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# CONVEYING AND ELEVATING MACHINERY

## STORAGE SYSTEMS, COAL AND ASH HANDLING DEVICES FOR THE POWER HOUSE

BY REGINALD TRAUTSCHOLD

A POWER HOUSE HAS BEEN termed a factory for the production of power, and such it surely is. But while in any other factory than the power factory, reduction of the manufacturing cost is the chief object of the management, still many otherwise efficient managers, experts in production economy, do not seem to know what they are paying for their power nor how to reduce its cost. Why is it that in so many cases these managers allow themselves to pay 20 to 100 per cent more for power than is necessary?

The reason probably is that they are themselves ignorant of the best way of reducing such cost, and are wary, perhaps, of calling in representatives of manufacturers of machinery for cutting down expenses because of previous expensive and unsatisfactory experience of adding costly machinery that has hindered instead of increasing efficiency, or of installing at the suggestion of a sales engineer machinery that was not of the kind best suited to the particular requirements of the plant but which was the specialty of the manufacturer represented by the agent. It is well, therefore, to know something about the necessities of your plant before undertaking to consult a representative of any house selling labor saving machinery.

The efficiency of any power plant depends, to a high degree, upon the methods and apparatus used for the handling of coal and the disposal of ashes, and to this feature of the power plant problem the scope of this article will be restricted, coal being considered, at all times, as delivered to the power plant or to its close vicinity.

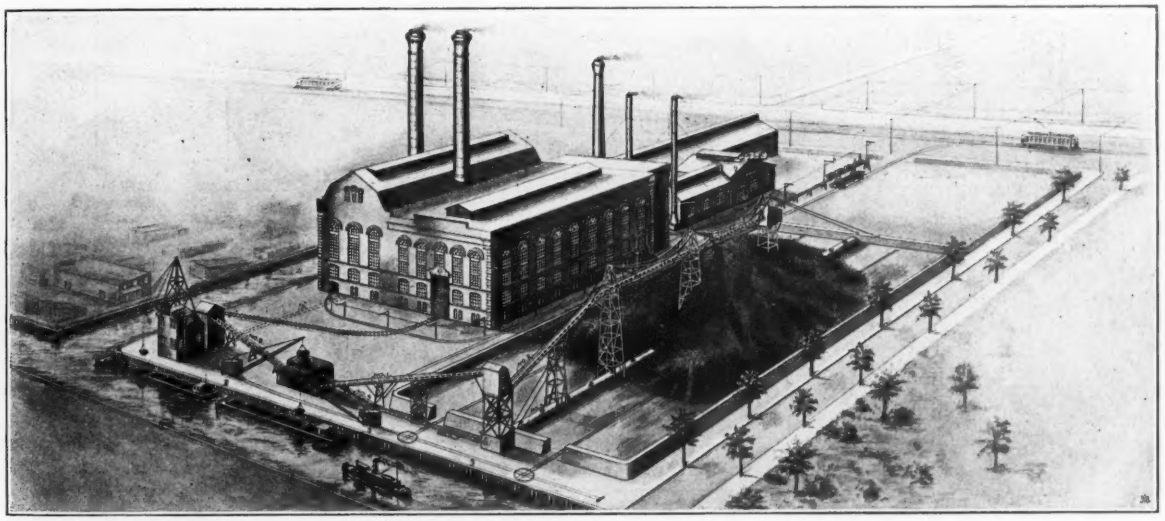


FIG. 2. BROOKLYN HEIGHTS RAILROAD CO. POWER HOUSE

### Storage of Coal

IN a plant making any pretense of cost keeping and modern management, the coal should first be weighed before it starts on its journey through the power plant. After weighing it is generally stored in

piles until such time as it may be needed for consumption. These piles may be formed either in the power house proper, usually in large bunkers over the boiler rooms, or may be independent of the building in which the boilers are located.

The former method has the advantage of having all the coal so located as to be easily fed to the boiler room or stokers by gravity, but possesses the disadvantage of considerably increasing the initial cost of construction of the power house building, owing to the necessity of more rigid construction of the walls than need otherwise be called for, and also the cost of heavy bunkers. In this system, too, there is the further disadvantage of restriction of storage space, necessitating frequent purchase of coal.

By having the main storage independent of the power building, the advantage is gained of a storage capacity as great as available space, with the result that, unless space is very restricted, which is unusual, coal may be purchased in large quantities, thus permitting the fluctuations of the coal market to reduce the fuel bills, and this outside storage may be in the open or may be housed in buildings of a light and cheap construction.

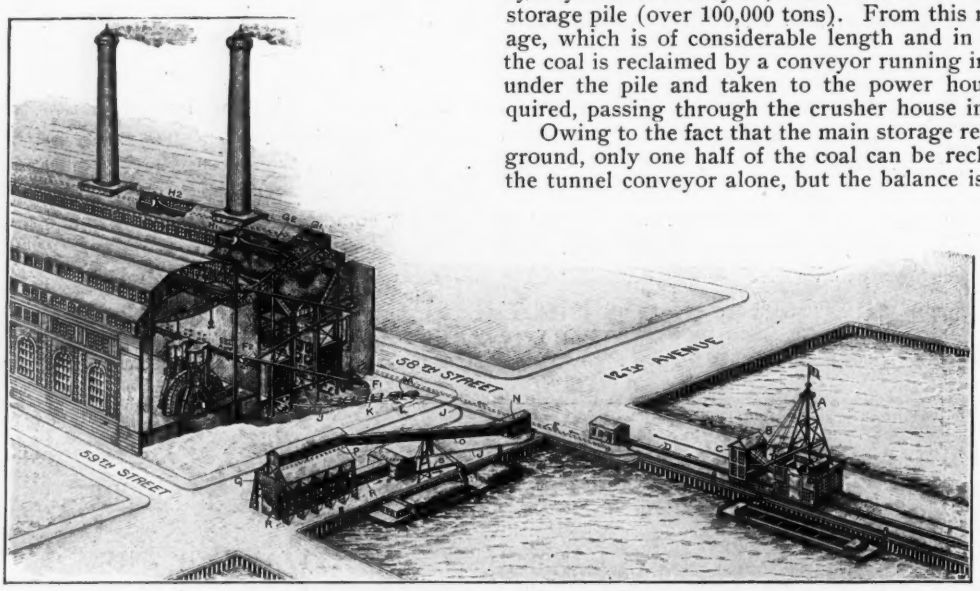



FIG. I. INTERBOROUGH RAPID TRANSIT CO. POWER HOUSE

As a drawback to this latter arrangement it must be considered that more conveying machinery for the handling of the coal is required, and this apparatus is expensive. Furthermore auxiliary storage bunkers should be installed in the power plant, and it is frequently found advisable to have an auxiliary system of conveyors for carrying the coal direct from the main supply to the auxiliary bins in case of accident preventing the usual supply from the storage piles.

### Applications of Systems

A CERTAIN large power plant in the east, developing over 1000 hp. uses the first of the above plans, that is, stores all its coal in the power house proper. This plant is situated near a river and the coal is received in barges and unloaded by a traveling hoisting tower delivering to a short conveyor leading to the weighing hoppers, where the necessary records of tonnage, etc., are made. On leaving the weighing hoppers it is conveyed directly to the power house, then elevated to a conveyor running above overhead storage bunkers, to which the coal is distributed. From this storage it is a very simple matter to draw the coal by gravity to the boiler room as it is required.

Another large power house in the same city is located where land is not so valuable and the plan of having the main storage independent of the power house building promised greater economy. In this instance, the coal is also received by water and the barges unloaded by a stationary hoisting tower or by locomotive cranes and passed through a crusher house where scales also are located, when required for immediate consumption. After being crushed and weighed the coal is carried by a system of conveyors to the auxiliary storage and is ready for consumption.

Coal for the main storage, independent of the power house, is unloaded by the locomotive cranes and then, by a system of conveyors, is distributed to a large main storage pile (over 100,000 tons). From this main storage, which is of considerable length and in the open, the coal is reclaimed by a conveyor running in a tunnel under the pile and taken to the power house as required, passing through the crusher house in transit.

Owing to the fact that the main storage rests on the ground, only one half of the coal can be reclaimed by the tunnel conveyor alone, but the balance is economically reclaimed by the locomotive cranes which, when not in use unloading barges, can be run over to the storage pile and used to feed the tunnel conveyor with the remaining coal. By this system coal can be put in storage or taken out at the rate of a couple of hundred tons per hour.

### Storage Capacity

BOTH the above mentioned plants are of large capacity. In power houses of smaller size the advantages of an independent storage although usually advisable are less noticeable, as the interior storage of these smaller plants is, as a rule, comparatively greater than would be possible to attain in a large plant, without very material increase in construction cost.

Right here it might be well to say a word in regard to what may be considered the economical storage capacity for any given power house, as this seems to be a point frequently entirely overlooked in the original layout of many plants, or, at best, arrived at by guess work. The average daily consumption, 10 hr. working day, of coal per boiler horsepower rating is about 40 lb., provided the fires are banked at night and reasonable care taken in the economical generation of steam. That is, a plant of 5000 hp. boiler capacity

might burn 100 tons of coal per day when running at or near its full capacity and it is necessary to plan for that amount of storage. In other words, the coal storage of such a plant should be so arranged as to enable 100 tons to be fed to the grates per day, without undue work or delay.

From storage, the problem is to get the coal to the furnaces and this brings us to a discussion of conveyors. For handling the coal supply of power houses and, to a somewhat lesser extent, for the disposal of ashes the use of belt conveyors is a favorite method, and frequently enables these operations to be performed at a minimum cost. In the foregoing a brief description has been given of the storage and handling systems of 2 large power plants, and a study of the uses to which belt conveyors are put in these plants will give an excellent idea of their value and adaptability. For convenience these plants will be referred to as "A," the first, and "B," the second.

### Conveying Systems

IN example A, Fig. 1, the first conveyor, that leading from the discharge of the hoisting tower to the weighing hoppers, is an example of a belt conveyor used as a component part of other types of equipment, being really an integral part of the tower and hoppers, which move together and are virtually one unit. This con-

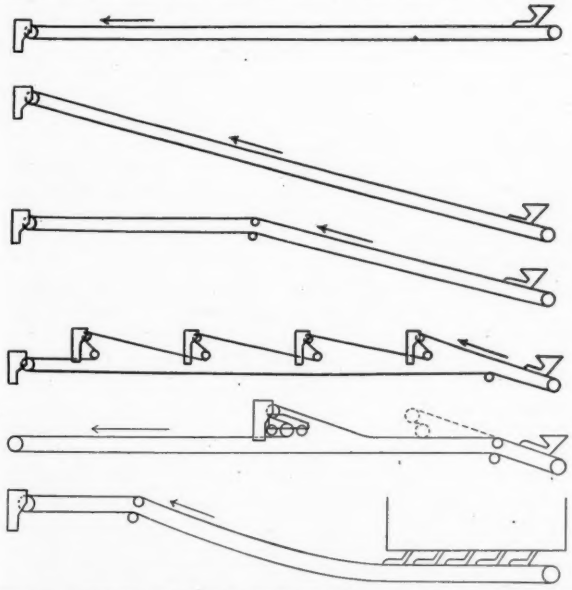


FIG. 3. TYPES OF BELT CONVEYORS, HORIZONTAL, PLAIN INCLINED, COMBINATION PLAIN INCLINED AND HORIZONTAL, HORIZONTAL WITH FIXED DUMPS, HORIZONTAL WITH TRIPPER, COMBINATION CURVED INCLINE AND HORIZONTAL

veyor is a short inclined one for carrying the discharge from the hoisting bucket to the weighing hoppers which are situated to one side of the tower proper, thus reducing the hoist that would otherwise be necessary if the hoppers were located under the tower as is frequently the case, and is therefore only a refinement in the unloading facilities. This scheme undoubtedly increases the capacity of the tower but its economy is questionable.

At this plant the hoisting tower and weighing hoppers travel along the dock for the simple reason that it costs less to move the hoisting apparatus than it would to move the coal barges and correspondingly increases unloading facilities. This arrangement necessitates a conveyor the full length of the possible travel of the tower to convey the coal discharged from the weighing hoppers to the power house.

In this case 2 belt conveyors are used, owing to the position of the hoist in reference to the power house and because a city street has to be crossed which necessitates dropping the second conveyor and running it to the power house in an underground tunnel. At the power house the coal is delivered to a system of inclined belt conveyors running back and forth up the rear end of the building. The last of these criss-cross

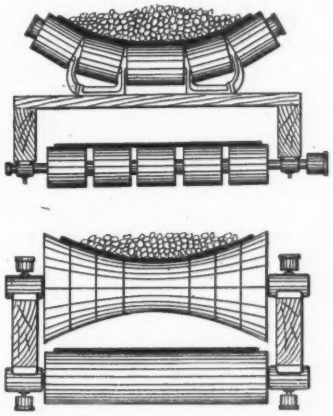


FIG. 4. BELT CONVEYOR IDLERS

conveyors discharges to either one of 2 long belt conveyors running parallel over the length of the coal bunkers, to the first one through a fixed dump (S kink in the belt permitting the side discharge of the load) and to the second by end discharge.

The 2 long conveyors are equipped with automatic trippers by means of which the coal is distributed over the storage area. The scheme of elevating by means of a belt conveyor possesses the advantages of large capacity and of minimizing the breakage of coal, but the economy of elevating by a system of such conveyors, running back and forth, is another point that will be taken up later.

Belt conveyors are also used in this plant for handling ashes and refuse, the ashes first being thor-

FIG. 5. AUTOMATIC TRIPPER

oughly quenched and cooled. For carrying the hot ashes from the boiler room steel cars are used. When cooled so that there is little danger of burning the belt the ashes are delivered to a system of belt conveyors. One inclined conveyor extends from the hopper to which the ash cars discharge and conveys to a suspended storage hopper in which the ashes are kept temporarily. The ashes are subsequently reclaimed from this bunker by a belt conveyor running under it

and the ashes carried to another belt conveyor on an adjustable boom used for loading barges with such refuse.

Example B, Fig. 2, presents no radical differences so far as the direct handling of the coal from the barges to the power house storage is concerned except that the hoisting tower is stationary and its bucket discharges directly to the crusher and scales. When the barges are unloaded by the locomotive cranes the coal may be taken either to the power house or to the main storage from a centrally located hopper to which the cranes discharge.

In the first case, an inclined belt conveyor carries the coal to the same crusher and scale house to which the stationary tower unloads. In the second case, another inclined belt conveyor leads to a long belt conveyor carried on an elevated trestle over the storage pile. This latter conveyor is equipped with an automatic tripper for distributing the coal over the storage area. The coal is reclaimed from this main storage by a belt conveyor in a tunnel under the coal pile; from which the load is received at any desired point, through

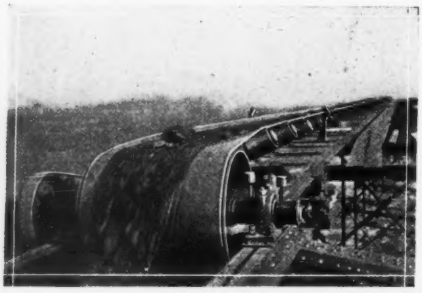


FIG. 6. END DISCHARGE BELT CONVEYOR

gates in the roof of the tunnel. This tunnel conveyor discharges, in turn, to another belt conveyor leading back to the central hopper, referred to before, and the coal is conveyed from there by the same apparatus and through the same steps as are employed in carrying the coal handled by the locomotive cranes direct to the power house.

These typical installations well illustrate broad possibilities as well as the uses and popularity of belt conveyors about the power house, but to the management points of greater interest are capacity of such systems, power required for operation and cost of equipment, operation, maintenance, etc. These points will be taken up in a subsequent article and presented in such form as to give to those interested as comprehensive an idea of the economic value of belt conveyors as a brief discussion will allow.

For the power plant views accompanying this article we are indebted to Robins Conveying Belt Co. of New York.

## PUMPING HOT WATER

IF your boiler feed pump kicks and don't like hot water, it is because the springs in the suction valves are too stiff. A feed water pump working on an open heater should have a head of water above it, as hot water cannot be sucked into the pump by atmospheric pressure, but has to run in. If the springs on the suction valve are too stiff they will hold the water back and will not let the water chamber of the pump fill. In a water pump that would not pump water above 200 deg. the suction springs were cut off so that water could be pumped in at 212 deg. This change affected an 11 per cent saving in fuel.

# MASONRY AND FOUNDATIONS

J. O. BENEFIEL

MOST of us have at times to do things which are new to us and we do not know the best way to proceed. Some time ago we wanted to remove about 50 ft. of brick wall 8 ft. high in a 3-story building to throw the first room into one with the room adjoining. We removed the wall and substituted columns without mishap, but we should have used for the lintels steel beams instead of the 12 in. square timbers and we did use steel in the course of time, for the timbers shrunk ½ to ¾ in., causing the supported wall to crack seriously. Since, we have turned the same trick without damage or sign of cracking by using steel beams for the lintels.

Another case of not using our gumption was in setting up an air compressor which is a fair size machine. When it came to leveling the frame and bedding we concluded to depart from our usual method of leveling up on iron or wooden wedges and shim up with thin pieces of steel, which looks good if you don't analyze the problem. The trouble with this method is that the frame rides on the iron shimming, and there might as well be no bedding. We had to chop out the bedding, remove the shims and level it up on wedges and grout it in again and afterward knock the wedges out and patch up where they had been. been.

We have always favored bedding in with stiff cement, ramming it under solid with sticks. This is a very good way if the foundation is wet thoroughly, so that it does not absorb water out of the grouting and make it rotten.

The safest way, perhaps, is to make a dam around the frame and mix up the cement and sand 1 to 3 with water enough to make it thin enough to pour freely; then take strips of iron bent so they can be got under the frame and work the grout well under; if this is not done the cement may settle near the point where it is poured and the parts farther under will have little cement and much water.

It is a question whether it is best to grout the bolts in solid or leave them loose in the pockets. We usually leave them loose where there are pockets or tunnels left in the foundation to give access to the nuts on the lower ends. Where the lower end is not accessible, we think they may as well be solid. We used to make a tapered wooden box to go around the bolts while the foundation was being made. We would coat the outside of the box with grease and wrap paper around that; thus made the box would slip out easily. The trouble with these boxes in some cases was that the wood would swell up, making it impossible to get them out. I have seen cases where they had to be burned out with kerosene oil to aid the combustion. Some favor old boiler tubes, which do well, but I like a 4 in. tin or galvanized tube best, and trim the top off and leave it in.

When we began to use concrete for foundations, we looked up what our friends, the civil engineers, had to say about it. One thing they agreed on was that there must be no clay in the gravel. This scared me much on our first job because it was pit gravel and contained quite a lot of clay, but when we had to dig into it, we found it all that could be wished.

We use around the gas generators and furnaces a cement composed of Portland cement, fire clay, salt and iron scale or boning. This is excellent for work of this nature, as it neither cracks nor crumbles and will stand some little pressure. The formula for this cement is: Fire clay, salt and iron scale equal parts, add an equal bulk of Portland cement. For setting generator tops or where there is traffic over it add sand to give it wearing qualities.

# KEEPING AND ANALYZING RECORDS

## DESIRABILITY AND IMPORTANCE OF KNOWING WHAT YOUR PLANT IS DOING

By G. F. Gebhardt

MR. OPERATING ENGINEER, suppose that the owner of your plant were to receive the following business proposal from a thoroughly reliable engineering organization:

"We can show you how to reduce your operating expenses 15 per cent without interfering with the regular operation of the plant and without cost to you. Our fees will be the saving effected for one year over and above the average yearly operating costs. After the first year the gain is all yours."

Suppose that this proposition were referred to you, what would you do? Would you admit your own inefficiency by accepting the offer, or are you in a position to prove positively that the plant is being operated at its best under existing conditions and that the company's service would be without purpose?

Are you prepared to show the variation in operating costs of your plant from time to time and the cause of these variations?

Do you know whether or not your plant performance compares favorably with that of similar stations?

If certain changes or additions are necessary for better economy, have you placed yourself on record to this effect?

Can you show your manager that he is getting power and heat cheaper than if central station service were acquired?

In short, are you thoroughly familiar with the details of your own plant?

If not, what is to prevent propositions from Economy Engineers, Fuel Specialists and Central Station solicitors from rendering your position untenable?

The day has passed when the duties of the operating engineer are merely to keep the plant running. The power plant is one of the important branches of any manufacturing business and is without doubt the most important element entering into the cost of maintaining tall office buildings, loft buildings and the like. The engineer should have complete charge of his plant and should be in a position to report on every factor entering into the cost of operation.

### Records Needed

TO DO this he must win the confidence of his employer and maintain a system of records which will place at his command the permanent and operating statistics of the entire mechanical equipment. Apparatus must be provided for weighing the coal and water; temperature, pressure and power measuring devices must be installed and provision must be made for keeping track of oil, waste, general supplies and repairs.

Owners can be induced to install these various testing instruments if they are convinced that such appliances will result in improved plant economy and that the results will warrant the additional expense. All of this will throw extra work upon the engineer, but the ultimate gain will more than pay for the extra effort.

It is not sufficient to record monthly or yearly averages. Daily records are absolutely essential for maximum economy. The various losses may be reduced to a minimum only by an intelligent analysis of daily records. A mere compilation of data without a careful study of the influencing conditions is without purpose.

### Making a Start

A COMMON mistake is to attempt too elaborate a system of records at the outset. Unless one has had considerable experience in recording observations the task will soon become irksome, guesses will be substituted instead of the results of actual measurements and the entire system will eventually be discarded. The most satisfactory results are obtained by a modest beginning.

After sufficient experience has been gained in recording, say, the weight of coal, quantity of water fed to the boiler, power output and the amount of supplies used, and the results have been studied with a view of reducing preventable losses to a minimum, then supplementary records may be added until a full system has been acquired.

It is true, unfortunately, that few power plants are properly equipped with testing instruments for observing all of the various factors entering into the cost of power, but this should not deter the operating engineer from making such records as the available equipment will permit. He should make it his business to convince the owner that the addition of certain devices will result in increased economy of operation. If operating engineers, as a body, were to co-operate in this manner few plants would be without the necessary apparatus for observing the conditions of operation.

Many engineers complain that their duties are such as to preclude any attempt at keeping records, even if testing appliances were available. This may be true, but it is surprising how much can be accomplished in the way of keeping records in a limited time, provided the necessary interest exists in the undertaking. It is a trite but true saying that the busy man can always find time for more work.

The results obtained from a correctly chosen and well kept system of station records are not fanciful, as some engineers imagine, but are productive of the highest economy. No successful business man would think of running his factory without a complete system of cost accounting, yet he regards the power plant as a necessary evil, and makes no provision for its economical operation.

The writer has made an extensive study of power plant economies and has found that reductions in operating expenses of from 5 to 30 per cent have been effected in every instance by engineers who have undertaken the extra labor of maintaining a system of records. How else, except by careful tests, is the engineer able to judge the depth of fuel and speed of chain grate best suited for the grade of coal at hand? How can he determine whether or not the chimney losses are excessive except by actual tests? How can he tell whether a change in operating conditions results in a gain or loss except by comparison of records?

If the engineer is not qualified to analyze the results of observations and draw specific conclusions then he should learn how to do so. Opportunities for instruction are to be found in many of the engineering associations, public evening schools, technical colleges and correspondence schools. It means work and lots of it, but the time will soon come when the operating engineer must be versed in station accounting as well as in operation in order to hold his own.

Begin now!

# FIGURES VS. CURVES

## WHAT EACH CAN BEST SHOW

IN keeping records and making comparisons either tabulated figures or plotted lines called for short "graphs" may be used. In some places one form has the greater advantage; in other places, the other form. For some records both tables and graphs are desirable.

In general tables are better where exact figures are needed and plotted records where the trend of the record is desired, that is the rise or fall of a value, or the comparison of its variation with that of other values.

For instance, in recording total heat units per indicated horsepower or station cost in cents per kilowatt-hour at the switchboard, it is desirable to have exact values, and curves, unless plotted on a scale so large as to be unwieldy will not give the desired accuracy of reading. But coal per kilowatt-hour, or steam per horsepower-hour for different loadings and station conditions can best be compared on graphical charts, which will show at once whether there is a tendency to increase or decrease coal and steam consumption, and a comparison of the 2 will show whether a change in the steam end of the plant or in the electrical end has caused the variation.

It should be remembered, however, in striving for extreme accuracy in figures, that no figure or computation can give a result more accurate than the measurement on which it is based. As an example, a steam gage is seldom graduated closer than 5 lb., and a reading is not taken with greater accuracy than 1 lb. If the reading is 108 lb., the accuracy of reading is 1/108 = 0.9 of 1 per cent or about 1 per cent. It is folly therefore to make any calculation of results based on this reading with greater accuracy than 1 per cent, or to the third figure other than zero.

### Examples

AS an example of values properly recorded in figures may be taken the costs per kilowatt-hour in office buildings for plants of various sizes. The figures are by C. C. Moore & Co. as recorded in Gebhardt's Steam Power Plant Engineering.

Values in daily records that are better shown in figures than in charts are irregular readings, such as time and amount of ashes removed, calorimeter readings of moisture in steam, gas analyses, moisture in coal. An illustration is the record of gases given in Kent's Steam Boiler Economy and partly shown herewith.

On the other hand periodic readings are more readily compared by graphs, and fluctuation of one value with change in another is most satisfactorily shown in this way. Typical of this is the record of total water and total coal used in a boiler test as given by Barrus. The steadiness of rise of both lines shows that the load was quite steady and that the evaporation per pound of coal did not vary materially. It is always interesting, too, to plot such readings as gage pressure and feed temperature, and to try to account for the fluctuations.

ANALYSES OF WASTE GASES MADE DURING TESTS OF U. S. S. "CINCINNATI" BOILER, ELIZABETHPORT, N. J., JUNE, 1900.

| Date. | Time. | Condition of fire when sample was taken. | $CO^2$ | O | CO | Pounds dry gas per Pound Carbon. |
|---|---|---|---|---|---|---|
| 1900. | | | | | | |
| June 15 | 4.58 | ..... | 15.2 | 3.8 | 1.0 | 16.8 |
| | 5.15 | ..... | 14.3 | 3.0 | 2.0 | |
| | 5.30 | Just before firing..... | 13.0 | 6.5 | 0.0 | |
| | 5.55 | One minute after firing..... | 12.5 | 6.7 | 0.8 | |
| | 6.16 | Just after raking..... | 14.3 | 3.7 | 1.0 | |
| | 6.27 | Two minutes after firing..... | 12.7 | 6.6 | 0.7 | |
| | 7.05 | Three minutes after raking and just before firing..... | 16.0 | 2.0 | 2.0 | |
| | | Average..... | 14.0 | 4.5 | 1.1 | |

In cost records, such as coal per kilowatt-hour, water per pound of coal, etc., a graph will show at once any drop below the normal and will call attention to the need of hunting the cause, to see if it can not be remedied. An example of such a record is shown in Practical Engineer, July, 1911, issue, p. 477.

Another use of plotting is to discover the law governing the effect of one quantity on another, such as effect of power generated by a boiler on its efficiency; effect of load developed by engine on its steam consumption. The curve showing variation of evaporation per pound of combustible with rate of evaporation per square foot of heating surface is an interesting

COST OF LABOR IN TALL OFFICE BUILDING POWER PLANTS.
SERVICE 18 HOURS, 2-10 HOUR SHIFTS.

(C. C. Moore & Co.)

| Size of Plant, Kw. | Labor per Month when Heating Plant only is Installed. | | | | | | | | Labor per Month when Complete Plant is Installed. | | | | | | | | | | | | | | | | | | Total Cost of Labor per Year with Plant. | Total Cost of Labor per Kw. Year with Plant. | Net Cost of Labor per Year Chargeable to Plant. | Net Cost of Labor per Kw. Year Chargeable to Plant. | Cost of Labor per Kw. Hour with Complete Plant, in Dollars. | | Net Cost of Labor per Kw. Hour Chargeable to Plant, in Dollars. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Engineer. | | Electricians. | | Handy Man. | | Pipe Fitter. | | Chief Engineer. | | Watch Engineer. | | Oilers. | | Firemen. | | Boiler Cleaners. | | Handy Man. | | Wipers. | | Switchboard Men. | | Generator Men. | | | | | | Load Factors. | | Load Factors. | |
| | No. | Rate | No. | Rate | No. | Rate | No. | Rate | No. | Rate | No | Rate | No. | Rate | No. | Rate | No. | Rate | No. | Rate | No. | Rate | No. | Rate | No. | Rate | | | | | *.2 .1233 | .4 .2466 | *.2 .1233 | .4 .2466 |
| 25 | ..... | ..... | ..... | ..... | 1 | $50 | ..... | ..... | 1 | $85 | 1 | $75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | $1,920 | $76.80 | $1,320 | $52.80 | .07111 | .03556 | .04889 | .02444 |
| 50 | ..... | ..... | ..... | ..... | 1 | 50 | ..... | ..... | 1 | 85 | 1 | 75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1,920 | 38.40 | 1,320 | 26.40 | .03556 | .01778 | .02444 | .01222 |
| 75 | ..... | ..... | ..... | ..... | 1 | 50 | 1 | 50 | 1 | 85 | 1 | 75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1,920 | 25.60 | 720 | 9.60 | .02370 | .01185 | .00889 | .00444 |
| 100 | 1 | 75 | ..... | ..... | 1 | 50 | ..... | ..... | 1 | 90 | 1 | 85 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2,100 | 21.00 | 600 | 6.00 | .01944 | .00972 | .00556 | .00278 |
| 150 | 1 | 75 | ..... | ..... | 1 | 50 | ..... | ..... | 1 | 90 | 1 | 85 | ..... | ..... | 1 | 70 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2,940 | 19.60 | 1,440 | 9.60 | .01815 | .00907 | .00889 | .00444 |
| 200 | 1 | 85 | ..... | ..... | 1 | 60 | ..... | ..... | 1 | 100 | 1 | 85 | ..... | ..... | 1 | 70 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3,060 | 15.30 | 1,320 | 6.60 | .01417 | .00708 | .00611 | .00306 |
| 250 | 1 | 85 | ..... | ..... | 1 | 60 | 1 | 60 | 1 | 100 | 1 | 85 | ..... | ..... | 2 | 70 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3,900 | 15.60 | 1,440 | 5.76 | .01444 | .00722 | .00533 | .00267 |
| 300 | 1 | 85 | ..... | ..... | 1 | 60 | 1 | 60 | 1 | 100 | 1 | 85 | ..... | ..... | 2 | 70 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3,900 | 13.00 | 1,440 | 4.80 | .01200 | .00600 | .00444 | .00222 |
| 400 | 1 | 100 | 1 | 60 | 1 | 60 | 1 | 60 | 1 | 100 | 1 | 85 | ..... | ..... | 2 | 70 | ..... | ..... | 1 | 65 | 1 | 65 | ..... | ..... | ..... | ..... | 5,460 | 13.65 | 2,100 | 5.25 | .01264 | .00632 | .00486 | .00243 |
| 500 | 1 | 100 | 1 | 60 | 1 | 60 | 1 | 60 | 1 | 100 | 1 | 90 | 1 | 60 | 2 | 75 | 1 | 60 | 1 | 65 | 1 | 60 | 1 | 75 | ..... | ..... | 7,920 | 15.84 | 4,560 | 9.12 | .01467 | .00733 | .00844 | .00422 |
| 750 | 1 | 100 | 1 | 60 | 2 | 60 | 1 | 60 | 1 | 100 | 2 | 85 | 1 | 60 | 2 | 75 | 1 | 60 | 1 | 70 | 1 | 60 | 1 | 75 | ..... | ..... | 8,940 | 11.92 | 4,860 | 6.48 | .01104 | .00552 | .00600 | .00300 |
| 1000 | 1 | 100 | 1 | 60 | 2 | 60 | 1 | 60 | 1 | 120 | 2 | 90 | 2 | 60 | 2 | 75 | 1 | 60 | 1 | 75 | 1 | 60 | 1 | 75 | 1 | 65 | 10,860 | 10.86 | 6,780 | 6.78 | .01006 | .00503 | .00628 | .00314 |

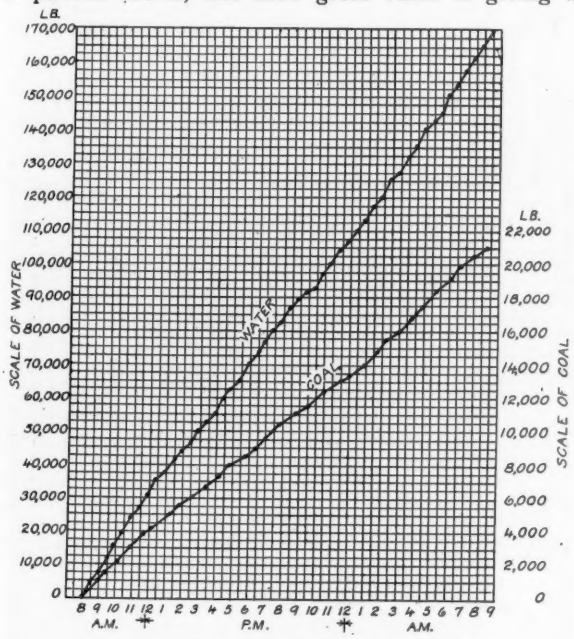
* Referring to above load factors, lower figures, .1233 and .2466, represent yearly load factors and are equal to $\frac{\text{Total kw. hrs. output per year}}{\text{Rated capacity kw.} \times 8760}$

Upper figures, .2 and .4, represent daily curve load factors and are equal to $\frac{\text{Total kw. hrs. output per year}}{\text{Rated capacity} \times 5400}$ (based on 300 days per year, 18 hours per day).

Above figures approximate only, depending upon size of units and conditions of operation. All plants assumed to have boilers for heating purposes. When complete plants are installed for lighting and elevator service, all elevators assumed to be electric.

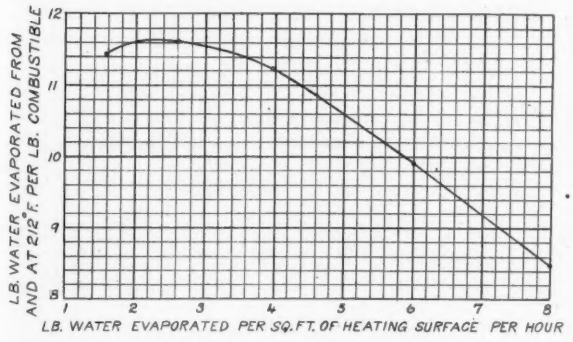
example, particularly in view of the present tendency to high evaporations per square foot of heating surface.

These examples will indicate the wide application of plotted charts, and their great value in giving a




PERIODIC READINGS COMPARED BY GRAPH

picture of conditions in the plant. Recording instruments automatically furnish many such charts in a modern plant, but where such conveniences are not installed, a sheet of squared paper properly noted with scale divisions and posted on a convenient board, will


LB. WATER EVAPORATED FROM AND AT 212° F. PER LB. COMBUSTIBLE
12
11
10
9
8
1 2 3 4 5 6 7 8
LB. WATER EVAPORATED PER SQ. FT. OF HEATING SURFACE PER HOUR

VARIATION IN FUEL CONSUMPTION WITH RATE OF EVAPORATION

easily receive the readings of instruments as taken, giving a chart which will fairly approximate an instrument record.

Comparison of records, both instrument and cost charts gives the means of tracing readily the progress upward or downward in plant economy.

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"Work of the right kind strengthens the body, and develops the mind and the character. Remember what you do today helps on what you do tomorrow. Your daily efforts are linked together and cannot be considered alone."

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THE COST OF FIRES each year is one-half the cost of all the new buildings erected in a year.

# CURVE PLOTTING

## EFFECT OF DIFFERENT SCALES

A GRAPHICAL record or curve, as we usually call it, is a record or series of records of results put into a form that enables one to make comparisons readily and easily or is a means of maintaining an uninterrupted story of performance. All curves are essentially the same, the only difference is in the method of their production.

### Terms Used in Plotting

FROM a point termed the "origin" one scale extends horizontally, generally to the right but not necessarily. All distances measured on this scale are "abscissas." The other scale, whose distances are known as "ordinates," extends vertically from the origin. The zero of each scale generally falls at the origin, but there are exceptions to this as seen in the first example.

One kind is automatically made by so-called recording instruments, of which the recording steam gage with its circular chart is such a familiar example that no further mention need be made of this type.

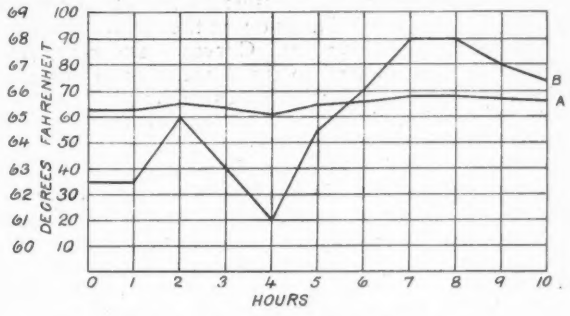



FIG. 1. TEMPERATURE CURVE

Those of the other class are manually drawn, or plotted, as we say, either directly from readings taken from some indicating instrument at regular intervals, or from derived data.

Again, curves may or may not be continuous; every point on the continuous curve represents the exact re-

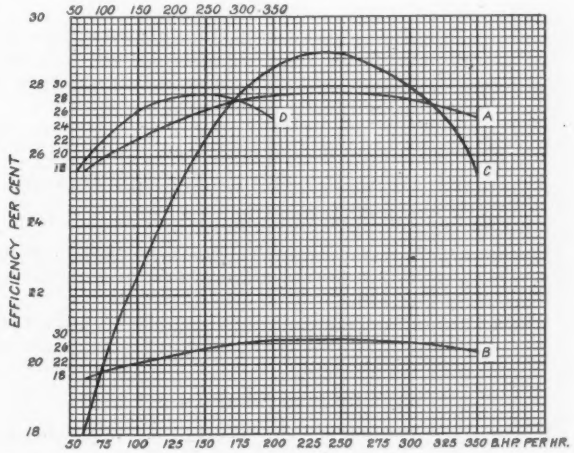



FIG. 2. EFFICIENCY CURVE PLOTTED TO DIFFERENT SCALES

lation between 2 quantities whose "ordinates" intersect at a given point.

The efficiency curve, chart 2, is such a curve, for at any horsepower output, the efficiency is represented by the corresponding ordinate.

The other kind of curve is represented by B, Fig. 1, which shows readings of temperature taken at hourly periods. Obviously, at the point where each ordinate representing the hour, intersects the curve, we have the temperature reading, but only at that point. The curve itself is meaningless, serving merely as a guide from one reading to the next. Supposing at a point half way between the 2nd and 3rd hours we were to consider temperature at 64 deg. F. as shown by curve B; in so doing we are likely to as great an error as though we call it either 60 or 70 deg., for since readings were taken only on the hour, we have no knowledge of any fluctuations which may have occurred between the hourly readings.

### Selection of Scales

THE degree of precision desired governs the choice of scales for the ordinates and abscissas; and the nature and range of the varying quantities we are dealing with determine the precision.

In general, for high precision, the scale divisions should be so chosen that we may read or estimate accurately the 10th of the numbered divisions; that is, let the last digit of the number to be read, be represented by the smallest division on the scale. Figure 1 is an illustration of this point. Curves A and B are from the same data, plotted to the 2 scales of ordinates at the left; the outer scale corresponding to curve B. Obviously where it is worth while to observe temperatures over so small a range of variation as 10 deg., certainly 10th of degrees are important. In curve A, the scale of ordinates is too small; there would be difficulty in reading the whole number of degrees; to read 10ths would be impossible.

In curve B, the scales are properly chosen affording the desired accuracy. The temperature reading at the 5th hour is plainly 64.5 deg., a figure not obtainable from curve A.

Looking at Fig. 2, the effect of employing various scales of ordinates is again apparent. The 4 curves, A, B, C, D are plotted from the same data. The positions of the scales indicate to which curves they belong.

For commercial apparatus, there is sufficient precision, if the efficiency can be read to ¼ or ½ of 1 per cent, for errors in observation, etc., would make closer reading valueless.

The ordinates of curve A, therefore, are well chosen, since the abscissas may be read to 10ths of divisions and, the ordinates to ¼ of the 10ths, or to ¼ of 1 per cent.

Curve B has its ordinates ½ as large as curve A. This not only makes for less accuracy in reading efficiency, but in general makes reading the curve more difficult.

The ordinates of curve C are plotted to too large a scale. It is clumsy looking, and we might say, unconventional, following as it does, the general shape of curves characteristic of other things.

Curve D illustrates the effect of using a shorter scale of abscissas, which crowds or humps the curve, approaching the shape of curve C.

### Comparing Curves

BOTH figures illustrate the effects of using different scales of ordinates and abscissas. Clearly, it is important that when comparing curves, say, for the efficiency of 2 different engines, we first compare the scales used; if there is a difference it is well to spend a few minutes to replot one of the curves over the other. By so doing they may be readily compared throughout their length with no possibility of error.

# RECORDS FROM INSTRUMENTS

## READING AND USING RESULTS

WHAT man in a power plant does not want his record to be at the top notch? Though his work cannot be improved upon with prevailing conditions, how can he prove it, how can he be assured that those in the office know exactly the class of work that he is doing? The steam gage may not vary a pound from the 100 lb. mark, but does anybody know that but himself? True, no man likes

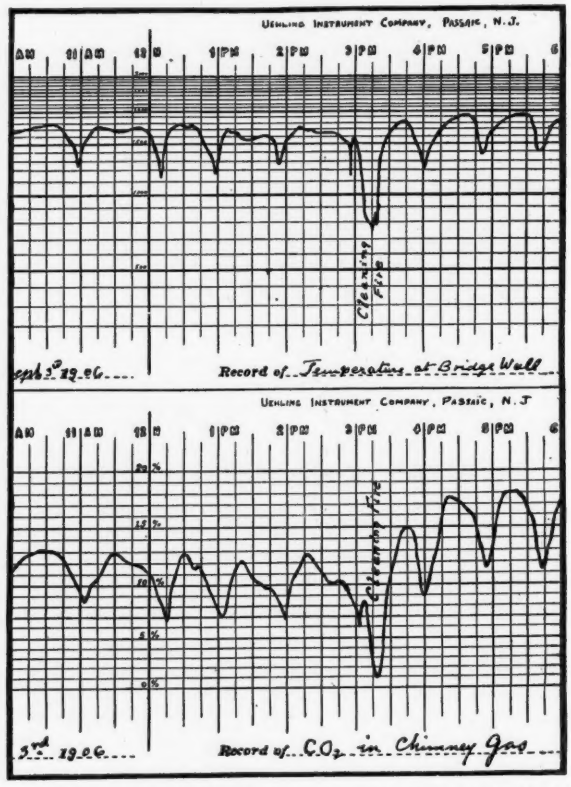

Uehling Instrument Company, Passaic, N.J.
Record of Temperature at Bridge Wall
Uehling Instrument Company, Passaic, N.J.
Record of CO2 in Chimney Gas

FIG. 1. RECORDS OF FURNACE TEMPERATURE AND CARBON DIOXIDE IN CHIMNEY GAS

to put his failures on record but an honest record deceives nobody and that made by a recording instrument is a friend to every man connected with a power plant.

### Forms of Instrument Records

THERE are 3 forms of record sheets commonly used for instrument purposes. These are the circular, drum and continuous charts. The circular chart is mounted upon a disk, revolved in any desired period of time by some form of clock mechanism. The pen, which draws the curve, is attached to an arm which is pivoted near the edge of the disk, the arm being of such length as to have the pen travel in a radial arc of the circles on the chart. Radial arcs correspond to the hours of the day while the circles upon the chart represent pressures or other values measured by the instrument, thus the travel of the pen is uniform in proportion to the pressure measured.

In some instruments the pen travels in a straight line and under those conditions the chart used has radial lines which represent time upon the chart.

When drum charts are used for recording values measured, the charts are secured to a drum that re-

volves in the desired time. In this type of instrument it is also common to have the recording pen travel in the arc of a circle, though in many cases it travels in a straight line. When the former method is used the lines representing the hours or time are arcs of a circle; in the latter case these lines are straight. In either case, however, the lines representing the values measured are straight and run around the drum.

Continuous charts are the same in form as the drum charts but have indefinite length and are drawn under a pen by a revolving drum with pins that fit into holes in the chart. It is not necessary in this case to renew the chart except at long intervals.

### Selection of Charts

DIRECTIONS given for proper plotting of curves in another article in this issue are equally applicable to curves plotted with instruments, as well as to hand plotting. Where rapid changes are apt to occur in the value to be plotted the speed of the chart should be

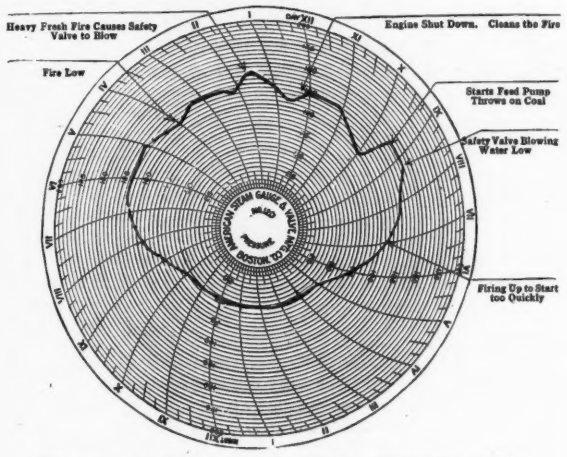

Heavy Fresh Fire Causes Safety Valve to Blow
Engine Shut Down. Cleans the Fire
Fire Low
Starts Feed Pump Throws on Coal
Safety Valve Blowing Water Low
Firing Up to Start too Quickly

FIG. 2. MARKED CHART FROM PRESSURE GAGE

higher than when the value is generally uniform. In the other direction the scale should be sufficiently large that one per cent of extreme variation is readily detectable. This will allow estimate even closer. When records are used only as a guide to direct the workmen during the time the record is being made, the circular chart is most convenient, but for a comparison of charts where it is desired to see how variation in one value affects another, the drum or continuous record serves the purpose best.

### Using Records

EVERY plant has certain conditions under which it works most efficiently. It is the engineer's duty to ascertain these conditions and when once determined to instruct his operators to hold as rigidly as possible to these conditions. The recording instrument should be in plain sight of the operator as it shows immediately when fluctuations are taking place, and by careful watch the cause for them will be found and can be removed.

In the office, the chart tells the story of the day's operations accurately, much more so than the most complete log an operator could keep. For example, take the record of temperature at the bridge wall of a boiler, shown in Fig. 1. It is readily apparent when the furnace door was open and how long it remained so by the temperature record. Also the heat loss due to the necessity of opening the door can be appreciated.

Compare this now with the record of the carbon dioxide in the chimney gas taken at the same time, which is also reproduced in Fig. 1. This shows that not only is the temperature over the bridge wall reduced by opening the furnace door, but a considerable decrease in per cent of carbon dioxide also results at each opening of the fire door. With diligence on the part of the fireman and such a record at hand, best operating conditions for the given material and equipment can readily be obtained.

As a guide to the fireman, Fig. 2 shows how the chart from a pressure gage used on a boiler may serve to advantage. Here the causes are pointed out to the operator. By watching his gage and using careful judgment it would be possible to eliminate such objectionable conditions as too rapid firing, safety valve blowing and low pressure due to starting feed pump and throwing on coal at the same time.

## THE USE OF GRAPHIC METERS

GRAPHIC electric meter records, are invaluable as an aid to scientific management in central stations and industral plants of all kinds. In the power plant they give a continuous record of the power delivered at every instant and serve a twofold purpose: first, to check the efficiency of the plant and determine the power output per pound of coal burned; and second, to show at what hours of the day the most power is demanded, so that additional generators can be started and made ready for operation.

There are many other uses to which the records can be put. Large manufacturing plants use them ex-

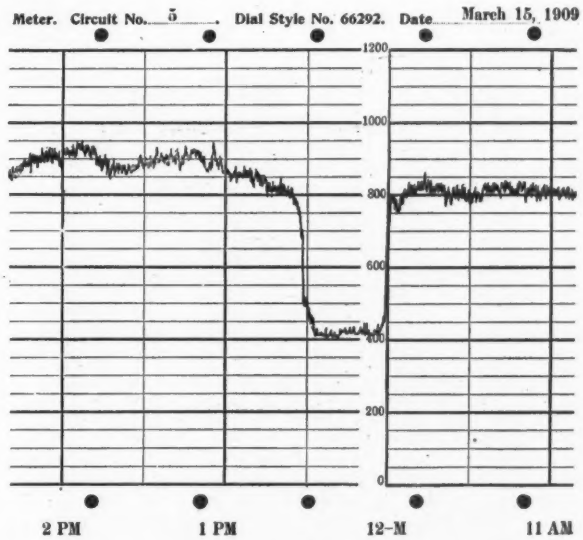



FIG. 1. TYPICAL GRAPHIC WATTMETER RECORD

tensively to determine and analyze the power requirements and operating cost of motor driven machinery. Many factories, textile mills, and machine shops are using them to analyze the cost, both in power and in time, of their various operations, with a view to cutting down the time lost between operations and excess power used.

Figures 1 and 2 show typical meter charts made on a Westinghouse graphic wattmeter. Figure 1 is part of a record made in a manufacturing plant, and shows the noon-hour "dip." It also discloses the fact

that practically half the total power used in the factory was required to drive the idle shafting during the noon hour. It shows too, that while the entire working force went off promptly at 12, most of the machinery was not started up again until 10 minutes after the proper time, and some as much as 20 minutes late.

Figure 2 illustrates a method of analyzing machine tool operations. The record shows the varying amounts

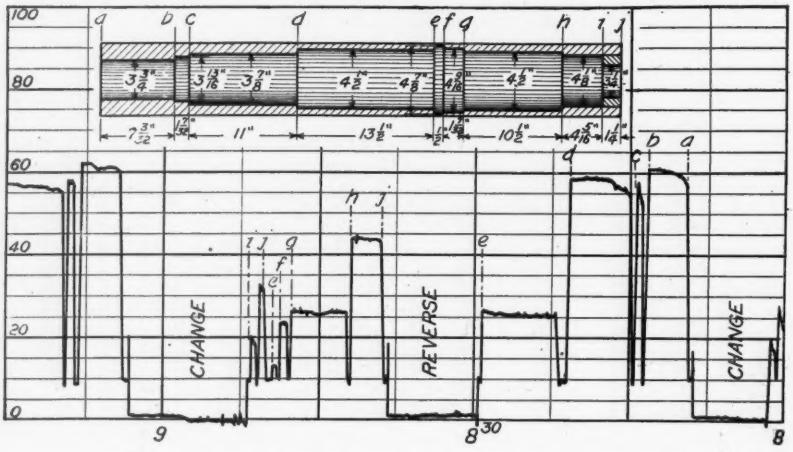



FIG. 2. METER ANALYSIS OF MACHINE TOOL OPERATION

of power required for making the various cuts, and the time lost in shifting the work. A record of this kind enables changes to be made to increase the efficiency of the machine.

The advantage of using graphic meters lies in the fact that they record electrical measurements ac-

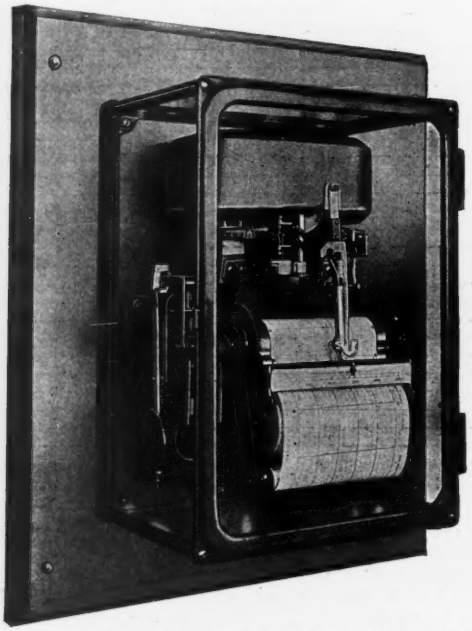


FIG. 3. WESTINGHOUSE SWITCHBOARD GRAPHIC WATTMETER

curately, and with reference to time. To obtain the same records in any other way would necessitate taking a large number of readings at regular intervals and even then the result would be only approximate. These readings would have to be taken so quickly that there would be large likelihood of error. The graphic meter does all this automatically. It shows the number of watts or amperes or volts supplied at every instant, with an accuracy depending on the instrument used.

The Westinghouse graphic meter, on which the accompanying charts were made, is an instrument of

FIG. 4. RECORDING GRAPHIC METER PEN USED ON WESTINGHOUSE INSTRUMENTS

great accuracy. In many graphic meters the measuring coils have to move the pen over the paper, and the resulting friction causes more or less inaccuracy and lack of sensitiveness. In these instruments the "relay principle" is used; that is, the measuring coils close the circuit of a pair of pen-operating solenoids whenever the power rises or falls, and the solenoids move the pen until its indication corresponds to the amount of power being delivered, when the contact opens. In this way a very heavy moving force is applied to the pen, even for a very slight variation in power, but the measuring coils have no load upon them. This results in great accuracy and great sensitiveness.

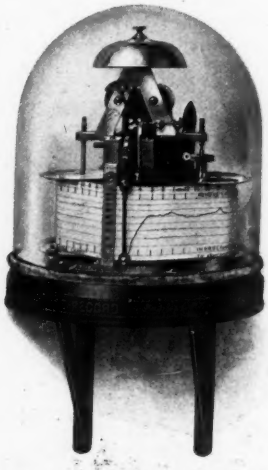
The chart consists of a roll of paper 248 ft. long, moved by a standard high grade clock mechanism at the rate of 2, 4 or 8 in. per hour, depending on the instrument selected. Two inches per hour is the usual rate, so that a roll of paper lasts for 2 months without change. The clock is an excellent time keeper, and is self winding. The pen contains one month's supply of ink and is of special self-feeding design. It operates on the capillary principle and the feed is uniform at all temperatures. The marking point is a hard iridium alloy tube that will not clog or scratch the paper.

In addition to the wattmeter, these meters are made as ammeters, voltmeters, power-factor meters, and frequency meters, the general design being the same for all and all utilizing the relay principle referred to. They are made by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., which has just issued a circular describing them in detail.

## EDSON PRESSURE RECORDING AND ALARM GAGE

THIS gage is designed in various styles for indicating and recording steam, air, gas, water, ammonia and other fluid pressures as well as for use on vacuum systems. The recording mechanism is primarily actuated by a corrugated diaphragm of steel, tempered and

treated by a special process. This diaphragm is protected by a non-corrosive lining, is placed horizontally within the recess in the supporting base of the gage and is enclosed by a concave iron cap so secured at its periphery as to form a steam tight chamber beneath the corrugated diaphragm. Pressure is admitted at the center of the iron cap and causes a movement of the recording point in proportion to the force applied. A scale is provided which enables the pressure or vacuum to be read without reference to the chart.



EDSON PRESSURE RECORDING AND ALARM GAGE

The instrument is constructed to correct automatically for any temperature reaction. The chart used is rectangular and may be removed each day from the instrument and filed. Either lead or metallic marking points are provided, the latter being used with specially prepared paper. The alarm feature may be provided to ring at any desired point of either high or low pressure or both. The alarm bell may be located within the gage case or at a distance.

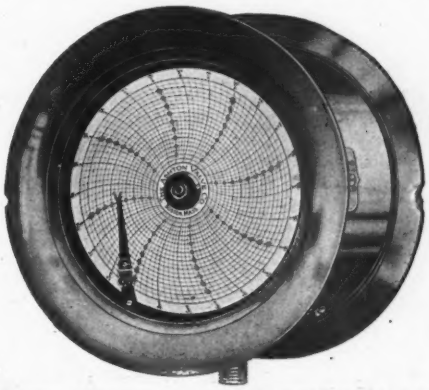
FIG. 1. BRISTOL RECORDING PRESSURE GAGE

The Edson pressure recording and alarm gage is made by the Ashcroft Manufacturing Co., of New York.

## ASHTON IMPROVED PRESSURE RECORDING GAGE

SOLID drawn brass seamless tubes are used in Ashton gages, and the gage movement is of durable construction with German silver pinions and arbors. The clock movement is enclosed in a separate casing, being thus protected against dust or moisture.

The record is obtained on circular charts or dials; the pressure graduations are indicated by circular lines and the hours of the day by radial arcs. The regular style dial is marked up for 24 hr. service, but special styles are made for either a greater or lesser time duration. The instrument is equally adapted for



ASHTON IMPROVED PRESSURE RECORDING GAGE

steam, water, ammonia, air or gas pressure service, and being circular in form makes a uniform appearance when fitted to gage boards, on which regular style pressure gages are installed.

## BRISTOL RECORDING GAGES

FIGURES 1 and 2 show the exterior and interior views of the standard Bristol pressure recording gages. They are mounted in solid bronze cases in any finish desired. Construction is rugged and recorder is

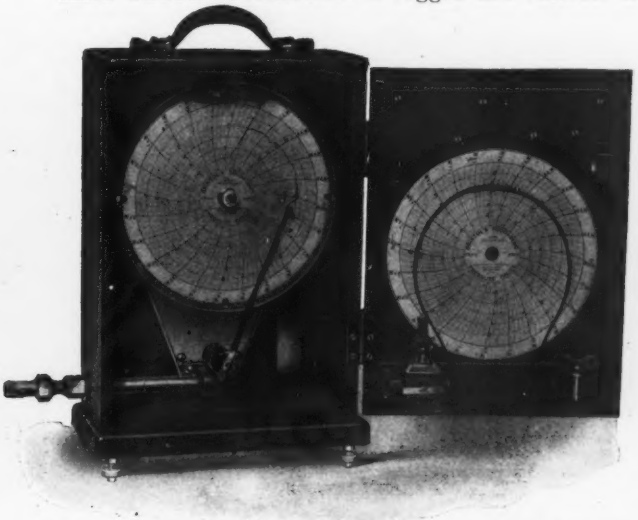


FIG. 2. INTERIOR VIEW OF BRISTOL PORTABLE RECORDING PRESSURE GAGE

easily operated. This recorder may be had for pressures from zero absolute up to 10,000 lb. per sq. in., and to run at various clock speeds. It is suitable for a large

variety of applications, being made to read in pounds, ounces, feet or in metric units, as desired.

Figure 3 shows the Bristol recording water level gage. In this device a capillary tube connects the recorder with a casting, the chamber of which is separated from the chamber of the lower casting by a flexible rubber diaphragm. In the lower casting are holes to admit water pressure against lower side of diaphragm which pressure compresses the air in the upper chamber proportionately to the head of water above the diaphragm. The capillary tube allows the recorder to be placed in any remote position.

In Fig. 4 is illustrated the Bristol recording thermometer built for all conditions of heat up to 1200 deg. F. By use of a flexible copper capillary connecting

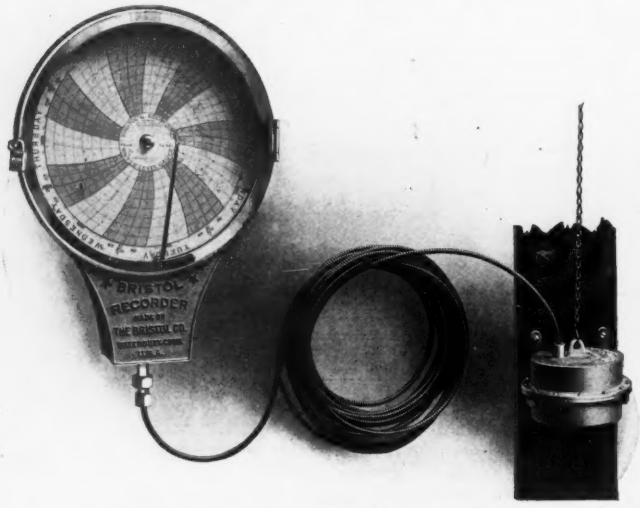



FIG. 3. BRISTOL WATER LEVEL GAGE

FIG. 4. BRISTOL RECORDING THERMOMETER

tube it may be situated at any distance from the source of heat. The instrument depends, for its operation, upon the expansion of the vapor of a liquid. In reality it is a recording pressure gage attached by a tube to a bulb containing a liquid and its vapor which changes its volume readily with changes in temperature.

Bristol recording electrical instruments are of the original form as shown in the voltmeter, Fig. 5. Al-

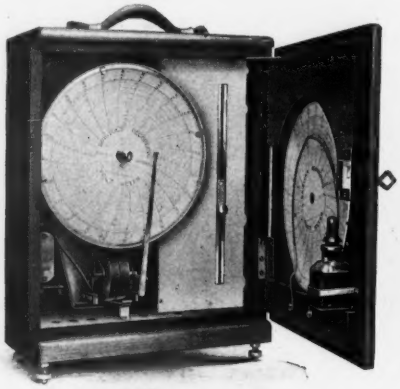


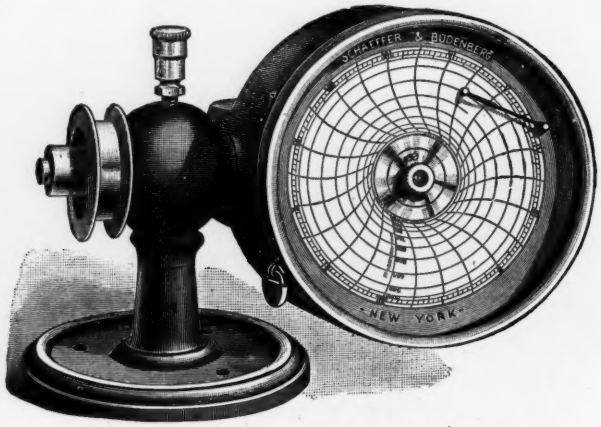
FIG. 5. BRISTOL RECORDING VOLTMETER

though this is for portable use other designs are available. This type is constructed for interchangeable use on a. c. or d. c. circuits. The 2 current coils have been wound to repel thus making them non-inductive with respect to each other. The electrical movement has a special form of multiplying device which is similar to that used in Bristol wattmeters. The instrument is constructed on the electrical balance principle without permanent magnets and is provided with a damping device which increases the steadiness of the instrument.

## SCHAEFFER & BUDENBERG RECORDING INSTRUMENTS

RECORDING tachometers, manufactured by the Schaeffer & Budenberg Mfg. Co., are designed to furnish a written record of the fluctuations in the speed in all such machines of which it is essential to know at all times the exact speed at which they are moving. They also show the time of starting and stopping and the speed at any particular time of the day.

Operating mechanism consists of a governor ring obliquely mounted on a revolving shaft, which is compelled by centrifugal force to occupy a position more nearly at right angles to the shaft and this action is



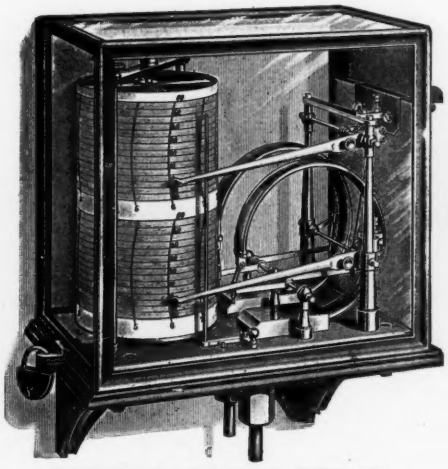

SCHAEFFER & BUDENBERG TACHOGRAPH

controlled by a spiral spring. The corresponding movement is communicated directly to the recording pen.

Clock movement operates a disk to which a chart is attached and revolves once in 24 hr. The recording

pen draws a line on the chart, whose radial lines represent the time of day and the circular lines correspond to speed.

In many plants it is desirable to compare 2 pressures to see how one varies with changes in the other. The Metropolitan Duplex pressure recording gage makes such comparison easy by the use of 2 gages that record on the same sheet. The drum is made double the ordinary height and is operated by clock movement to revolve once in 24 hr. The recording pens are operated by Bourdon tube springs through a system of levers to give the desired amount of travel on the record sheet.



METROPOLITAN DUPLEX PRESSURE RECORDING GAGE

COLUMBIA RECORDING GAGE

Being compact and simple, the mechanism of the Columbia recording gage is especially adapted for recording the pressure of steam, water, gas or air and may be placed near the boiler or at some distance, as in the office.

It is provided with a clock movement to which is attached a metal disk with chart making one revolution in 24 hr. The chart used is usually one with circular lines to represent the pressure and radial arcs to indicate hours of the day.

Columbia recording thermometers employ a mercury-filled steel spring, steel bulb and steel capillary tube to operate the recording pen. The record is made on a circular chart and the instruments are capable of recording temperatures ranging from 30 deg. below zero to 1000 above.

Pressure due to temperature of mercury in the bulb, placed at the point whose temperature is required, is communicated to the instrument through a flexible steel capillary connecting tube which enables the instrument to be placed away from the heat destructive to its mechanism and where it can readily be observed.

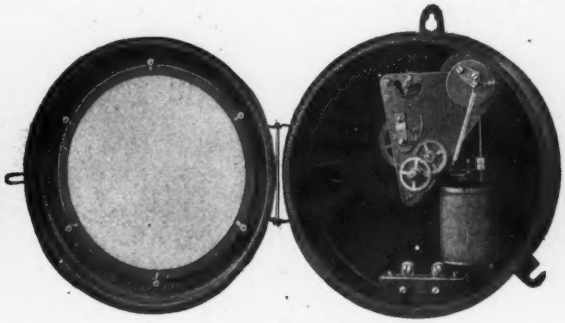
## GENERAL ELECTRIC RECORDING INSTRUMENTS

FLOW meters made by the General Electric Co. depend for their action upon the difference in pressure on leading and trailing openings in a nozzle plug inserted in the pipe. The leading set of openings faces

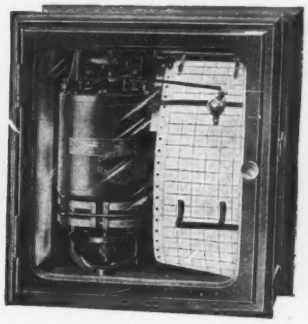
RECORDING FLOW METER

the current of water, steam or gas, as the case may be, the trailing openings are placed one opposite and 2

SWITCHBOARD TYPE CURVE-DRAWING METER



INTERIOR VIEW
CURVE-DRAWING METER



G. E. CURVE-DRAWING WATTMETER

at right angles to the leading set. The water impinging against the leading openings, sets up a pres-

sure in them which equals the static pressure plus the pressure due to the velocity head. The pressure in the trailing set is equal to the static pressure minus the pressure due to the velocity head. These pressures communicated to 2 mercury cups which are connected at their bottoms and placed on a balance arm. Any difference in pressure in the 2 cups causes an unbalancing which is communicated to a pen that draws a record of the flow. The rate of flow is given in gallons a minute in pipe of any size at any condition of temperature or pressure within the range of the meter, on a continuous chart.

Internal parts of General Electric curve-drawing ammeters and voltmeters consist of the clock mechanism and measuring element. The spindle carrying the pen arm has cylindrical pivots and runs in jewels thus keeping the pen always in alignment.

The electrical element is of the solenoid type with gravity control. This construction makes the instrument adaptable for alternating or direct current. To render the needle dead-beat, an aluminum damping disk is operated from the armature shaft through gearing so that a large movement of the disk is obtained with a small movement of the pen. An exterior and interior view of the instrument is shown herewith.

Type C curve-drawing wattmeter for switchboard service is in both mechanical and electrical design such that high initial accuracy is obtained. By correct proportioning of the various elements a high torque is secured which insures continued accuracy. While primarily designed for alternating current the instruments can be used with good results on direct current circuits not exceeding 200 amperes or 750 volts capacity.

(Continued on page 782.)

# SOME POINTS CONCERNING FIRE TOOLS

## SHAPES, DIMENSIONS, CARE AND USES OF FIREMAN'S IMPLEMENTS

By R. S. Kelly

A COMMON but extremely unhandy form of rake is shown at A, Fig. 1. The tines or prongs are of such form that the tendency is to ride over the top of the fire, and it oftentimes requires heavy pressure on the handle to keep the rake down on the grates where it should be kept. The body of the fire should not be disturbed when it is possible to avoid it. When

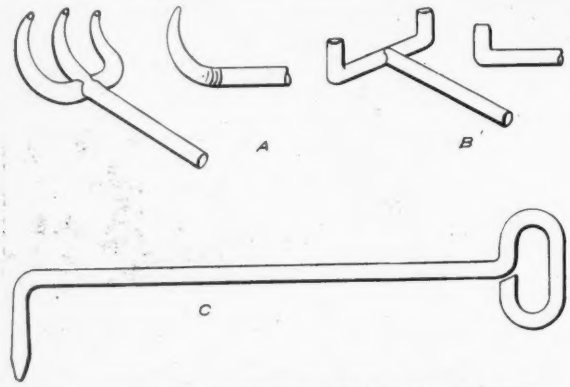



FIG. 1. RAKE CONSTRUCTION AND OLD STYLE POKER

this form of rake is used as a clinker hook the tendency is to work down into the fire, the prongs tending to sink deeper into the burning fuel, stirring it unnecessarily. At B is illustrated one of the best forms of rake yet brought out for hand fired boiler furnaces. The back is straight, and it is much easier to keep it

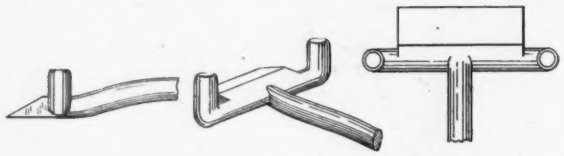


FIG. 2. COMBINED SLICE BAR AND RAKE

in contact with the grate bars, because the prongs are short and straight and there is no tendency to work either up or down when it is being pushed through the fire. When turned over the prongs serve as clinker hooks. Two prongs are by far preferable to three, because there is much less tendency to push the fuel in front of the rake. The rake is not to be used to stir the fire, but to remove the thin layer of ash which lies next to the grate bars, without disturbing the fire.

The hoe is the best tool to use for mixing the fuel in the furnace, and the process of mixing is one of the most efficient means known of producing clinker. As far as the process of raking is concerned, the rake will be found still more efficient if made without prongs, the object of the prongs being merely to convert it into a combination tool, viz., a rake and clinker hook, thus avoiding the necessity of changing tools

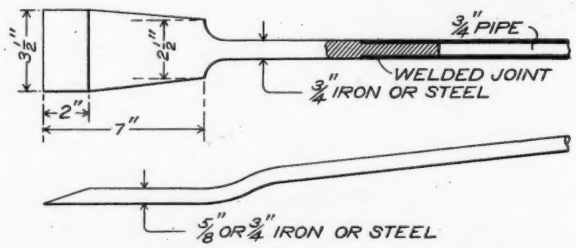



FIG. 3. DIMENSIONS OF SLICE BAR

while the furnace door is open. C, in Fig. 1, illustrates a style of poker that has long since been out-of-date. It is, however, sometimes employed with the locomotive type of boiler where the fuel is generally coarser, and the fire carried much deeper than is cus-

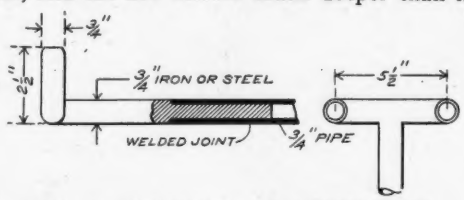



FIG. 4. DIMENSIONS OF 2-PRONG RAKE

tomary with the return tubular boiler. For other than the locomotive boiler it is one of the most unhandy tools that can be devised.

Three views of a very convenient tool are given in Fig. 2. This is a combination of the slice bar and

flat back rack. It is an excellent tool for thin fires when a fuel containing considerable clinker is used. This rake loosens the clinker in its path and removes the ash with a single thrust, and avoids changing tools, especially with a thin fire, which is greatly affected by an inrush of cold air. When raking, the effect is practically the same as with the plain 2-prong flat back rake.

The dimensions of the fire tools previously mentioned are shown in Figs. 3, 4 and 5. It will be noticed that the prongs of the rakes are not sharp-

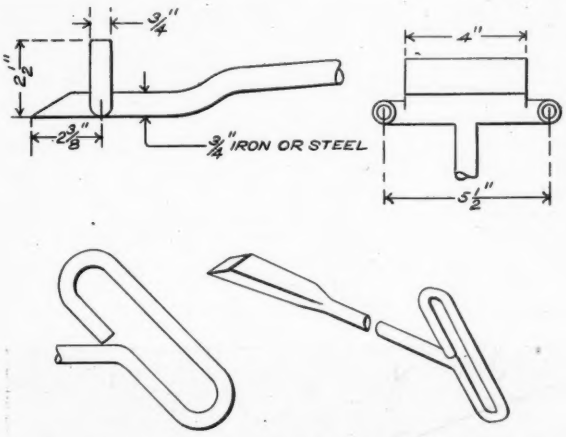



FIG. 5. DIMENSIONS OF COMBINED SLICE BAR AND RAKE
FIG. 6. SLICE BAR WITH BENT HANDLE

ened and that they are rather short. While the effect on the fire is all that can be desired, the blunt prongs have the advantage of not being liable to catch in the

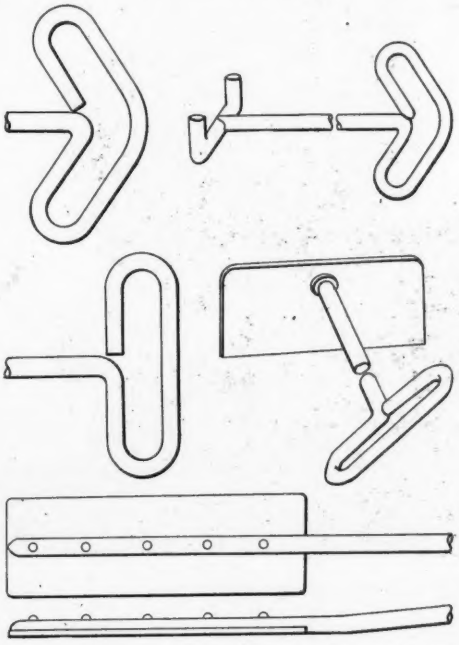


FIG. 7. RAKE WITH CONVENIENT FORM OF HANDLE
FIG. 8. HOE WITH HANDLE IN NATURAL POSITION
FIG. 9. PARALLEL HOE TO REMOVE FIRE SIDEWISE

slots or air spaces between the grate bars when the rake is either intentionally or unintentionally used with the prongs extending downward.

It frequently happens that fire tools become overheated when allowed to remain a little too long in the furnace, and when one or both prongs catch in the grate, the tool may be ruined before it can be extricated. A sharp point is of no assistance in removing clinkers, because the latter are practically impenetrable and are generally removed by being pulled out in the same manner as with the hoe.

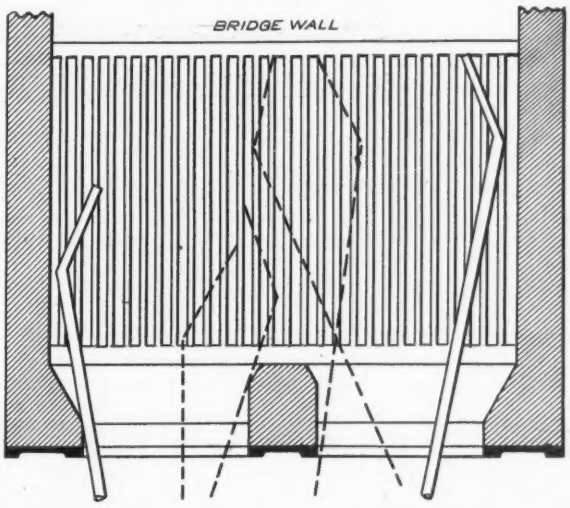


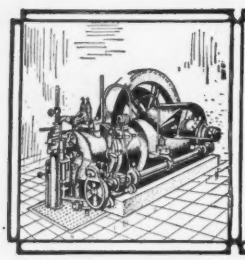

FIG. 10. POSITION OF PARALLEL HOE WHEN MOVING FIRE SIDEWISE

Figures 6, 7, and 8 illustrate some convenient forms of handles and the angles at which they are bent with reference to the business end of the tool.

When the fire is to be moved sidewise, as when cleaning the fire, a "parallel hoe," as shown in Fig. 9, is found to be a convenient tool. The blade is preferably 3 or 4 in. wide and 12 in. long, and is attached to the handle at about the middle of the width of the blade so that there is no tendency to turn round when pushing the fire sidewise in the furnace. The handle is bent slightly, as shown.

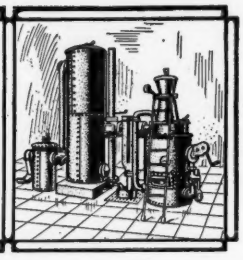
Figure 10 illustrates the positions of the hoe when moving fire sidewise in the furnace. It is a good plan to have 2 shovels in the boiler room, 1 to be used for firing fresh fuel only, and the other, the worn shovel, for removing hot clinkers and cinders. When handling the hot cinders, the blade of the shovel becomes annealed to an undesirable extent, and, being very soft, the edge rolls up very easily and this will cause much trouble when it is used for firing, in preventing the proper distribution of the coal over the fre.

Distribution or spreading of the coal also depends to a great extent on the angle between the blade of the shovel and the handle. For stationary boilers better work can be done, and it can be done more easily, with what is known as a straight shovel or scoop. The shovel is not exactly straight, but comparatively straight, when placed beside an ordinary coal or grain scoop. With the latter style it is necessary to raise the outer end of the handle in order to spread the coal nicely over a horizontal grate, while with the straight scoop both hands may be kept on the same level, which will be found much more convenient. The straight scoop is commonly known as a "gas" scoop, while the other is merely a common scoop as far as the angle between the handle and blade is concerned.



# Gas Power Apparatus

## Producers, Engines and Industrial Applications



# INTERESTING NEW SUCTION GAS PLANT

By C. Van Langendonck

IN the accompanying illustration, a new and simple form of gas plant using all classes of bituminous fuel is shown; the inventor claims that his gas engine is constituting an ideal solution of the problem of the employment of bituminous coal as regards users of small moderate amounts of power.

As is seen on the illustration, the generator is rectangular in form; the back is vertical and corresponds to the wall against which the fuel is heaped, the sides project forward from this back, while the front is inclined towards the back in such a way as to form a cover to the inclined face of the heap of fuel; the incline of the front towards the bottom of the generator is to reduce fuel space and also to keep the fuel in the best position.

The generator is of the down draft type, the vertical part of the top is the container, the sloping front on its underside constitutes a natural passage for the gases and volatile matter distilled at about the commencement of the slope which is placed near the bottom of the generator. On each side of the generator and at the bottom of the slope will be seen box castings with covers and movable lids, these are air supplies for maintaining the fuel in the natural passage at the necessary temperature for the conversion of the volatile matter.

The fuel on the underside of the sloping front must always be the loosest and yet as the fuel is consumed the fuel from above rolls down and keeps it sufficiently full to prevent any space being formed where the gases would burn. The fuel in the generator rests upon ordinary grate bars, through which ash, etc., drop into the chamber below and are removed from time to time. The main air supply is placed at the back of generator; steam is admitted to each air inlet.

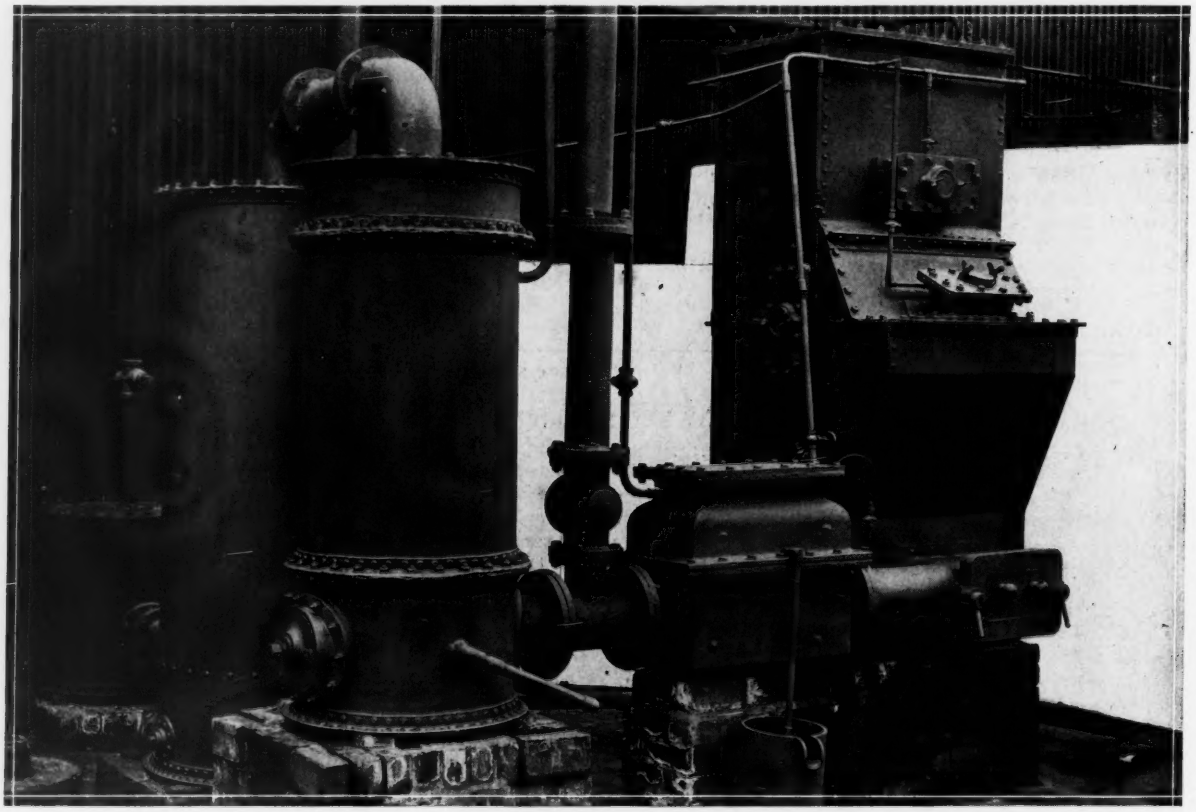


FIG. I. PRODUCER GAS PLANT USING BITUMINOUS COAL

The gas pipe is seen leaving the chamber at the bottom of generator, it then enters a generator for raising the steam required; from there it enters a cooler consisting of a series of tubes through which the gas passes, these tubes being contained in a cylinder full of cold water. From here the gas is led into an ordinary coke scrubber, thence to the expansion box and gas engine.

To start the plant from cold, the generator is filled up to the level of the main air inlet with gas coke; on top of this a fire is lighted; when burnt up sufficiently a hand power driven blower is worked until sufficient temperature has been attained to give a combustible gas. The engine is then started, the fuel container filled with coke, the air openings adjusted and steam admitted. As the coke in the container falls, bituminous fuel is fed in and the generator worked on this alone. This coal resting upon incandescent coke, gives off its volatile matter and becomes coked; the volatile gases, formed at the main air inlet, are drawn downwards to the gas outlet, following the path of least resistance, provided by the sloping front, for here the fuel, although in contact with the underside of the slope, is not packed but loose. As the fuel in the lower part of the generator is used or wears away, it is automatically replaced by the coked coal, which, according to the natural result of adding to any heap of material, rolls down the underside of the sloping front and so keeps this natural passage for the gas always full of fuel, but in a loose condition. The distillation of the volatile matter, the formation of coke and the supply of it to the lower part of the generator go on automatically, the generator is so constructed that the rate of coking the coal exactly equals the consumption of coke in the lower part, thus ensuring a regular quality of gas. At night coal is fed in until the container is full, steam is cut off, air supplies adjusted and the plant left. In the morning, beyond stirring the fuel bed, little has to be done before starting the blower, gas will be generated in a few minutes and the engine on its working load in 10 min. from start of blowing.

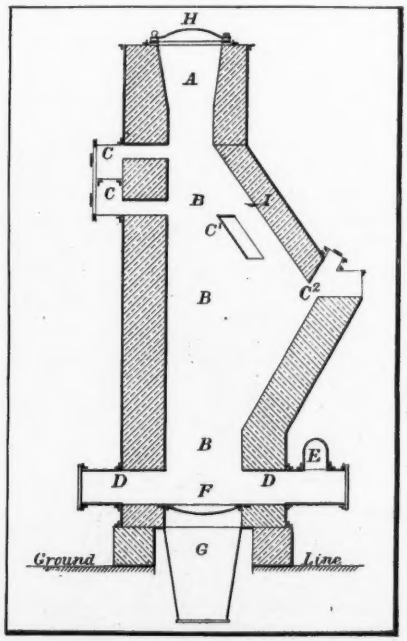



FIG. 2. SECTION OF GAS PRODUCER

The fuel consumption, using an average quality of coal yielding about 10 gal. tar per ton, is but little over 1 lb. per brake horsepower hour, with coals containing 12 gal. tar per ton and upwards the coal consumption is reduced to but little more than ¾ lb. per brake horsepower hour. The plant used for the demonstration was rated at 40 to 50 b. hp. and was working a Dudbridge gas engine rated at 53 b. hp. maximum, town gas, or 42 b. hp. producer gas. At the demonstration, a maximum of 50 b. hp. was obtained from the engine with gas from the gas producer. The engine has a cylinder 13¼ in. in diameter by 21 in. stroke and runs at 180 r. p. m. The demonstration lasted a week, the plant working each day, fire in generator being banked up at night, the usual load carried was 38 b. hp.

# MASTERING THE GAS ENGINE

By C. F. Swingle

IN THE October issue instructions were given regarding methods of locating the dead center, and also relative to timing the valves. It is now in order to devote a space to an explanation of the mechanism by means of which the valves are operated; in other words, the valve gear.

By the term valve gear is meant not only the cams, and cam shaft from which the valves directly receive their motion, but also the toothed gear which receives its motion directly from the crank shaft and in turn transmits it to the cam shaft. The form of this gear depends

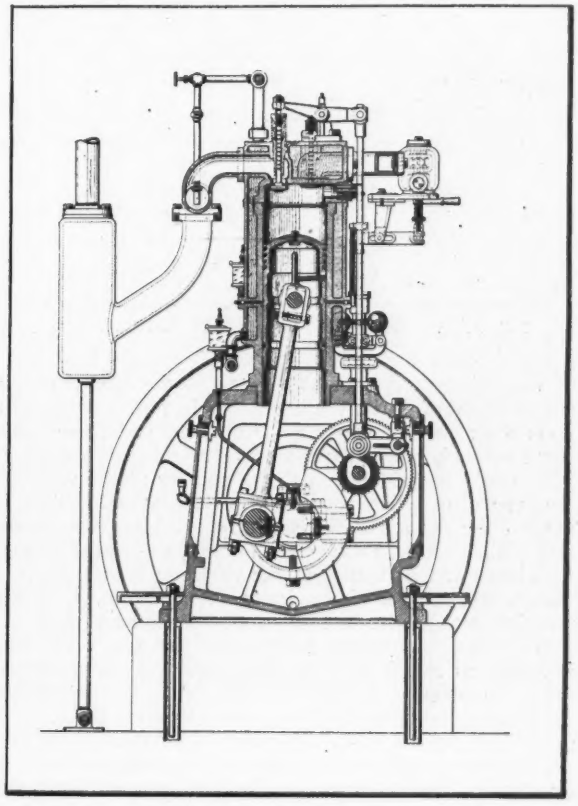


FIG. 1. DRIVING GEAR FOR VALVES ON 4-STROKE CYCLE ENGINE

upon the design of engine. On some engines it is of the spiral or worm type, and on others it is an ordinary cog gear, the driving wheel being secured to the crank shaft, and the driven wheel to the cam shaft.

### Driving Gears

ON horizontal engines, angle or bevel gears are usually employed. As the 4-cycle engine requires 2 revolutions of the crank shaft to one revolution of the cam shaft, the gears are 2 to 1, that is the diameter of the driven wheel is twice that of the driver.

Figure 1 illustrates an arrangement of this type of valve gear. One serious cause of trouble with this method

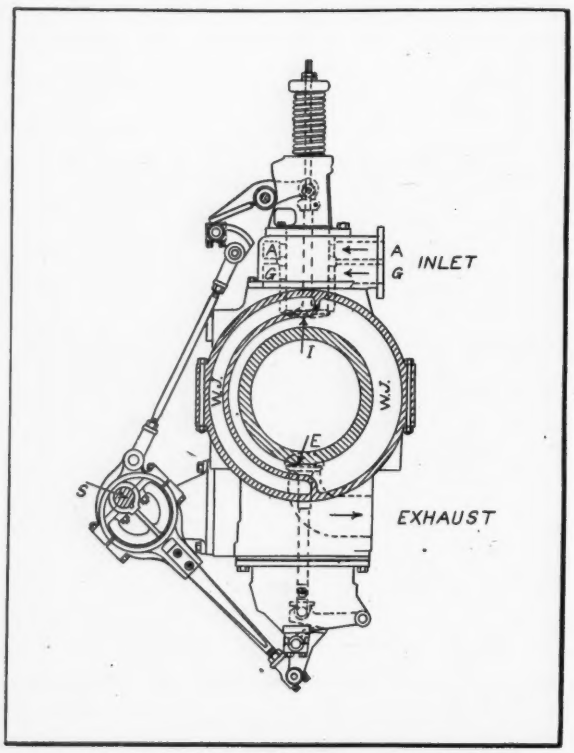



FIG. 2. VALVE GEAR OF HORIZONTAL ENGINE IN CROSS SECTION

of imparting motion to the valves is the fact that the actual strain of work, the hard duty in fact, always falls upon the same teeth at regular periods, and these teeth represent only a small percentage of the total number. This strain is sudden and sharp, coming at the moment that the cam which actuates the exhaust valve lifts it against the tension of its spring, and also the pressure still in the cylinder at the completion of the power stroke.

Thus but 2 or 3 cogs in the entire circumference of each wheel are doing practically all the work, while the remaining cogs merely serve to keep the cam shaft revolving, and the result is, that if the gears are not properly adjusted, and kept in correct mesh, and also cleaned and oiled daily, they will wear rapidly, and in time seriously affect the timing of the valves. Spiral gears are affected in the same manner, although they do not show it so readily. When the gears are enclosed in an oil tight case, as many are, the danger from dust, sand and other grit getting into them is not so great as when they are open, and exposed, but there is danger in allowing the same oil to remain for too long a time in the case, and thus become charged with dirt resulting from the normal wear of the cogs.

Probably the best lubricant for exposed gear wheels and also for cams, is a heavy grease mixed with graphite or plumbago. With the enclosed type a good machine oil is necessary, and, if there is some plumbago mixed with it, better results will be obtained.

### Valve Operating Devices

FIGURE 2 shows an end sectional view of a horizontal gas engine in which the valves are operated by an eccentric located on shaft S, which is caused to revolve by means of bevel, or angle gear connections with the crank shaft. A single eccentric imparts motion to both the inlet valve I, and the exhaust valve E, the motion of the eccentric being timed so as to open the valves at the proper moment. A is the air inlet and G is the gas inlet. W J is the water jacket space surrounding the cylinder.

Water is kept in circulation in this space for the purpose of cooling the cylinder and igniter; otherwise the temperature would become so high as to cause premature explosion of the mixture. Figure 3 shows another type of valve gear in which the valves are operated by a single cast-steel cam keyed to the lay shaft S, which receives its motion from the crank shaft in the same manner as the one previously described. The inlet valve is shown on the top of the cylinder, and the exhaust valve underneath. The water jacket W, is also shown. There are other styles of valve gear, differing somewhat in detail, but those illustrated will serve to give the student a general idea of the methods employed to transmit motion from the crank shaft to the valves.

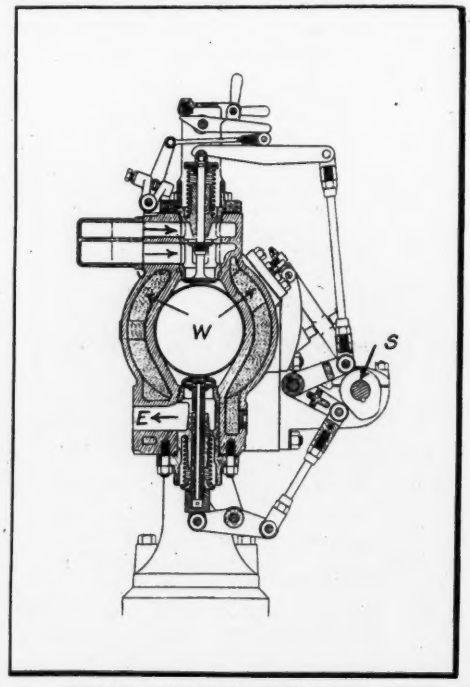



FIG. 3. SINGLE ECCENTRIC DRIVE FOR INLET AND OUTLET VALVES

In some of the smaller sized gas engines automatic inlet valves are used. These valves are operated entirely by the motion of the piston in the following manner:

Assuming the piston to be on its forward intake stroke, the vacuum created behind it will cause the valve to open and admit the explosive mixture. When the piston starts on the return, or compression stroke, the pressure against the valve, with the assistance of a light spring will close it, and it will remain closed until after the power stroke is completed, and the piston returns to begin another intake stroke.

About the only thing that can be said in favor of this type of valve is, that it is cheaper to build an engine with an automatic inlet valve than it is to build one with the inlet valves mechanically operated. It may also be said that the valve will always be in correct time with the crank.

Its disadvantages are, that it is noisy, and also that it is impractical for use on the larger sizes of engines, for the reason that it can only be timed for the opening and closing at the one point in the stroke of the piston.

### Care of Valves

IT IS very important that the valves of a gas engine be kept in good condition if efficiency in the working of the engine is an object, and it usually is. A leaky inlet or exhaust valve, or a valve that does not properly seat itself, due to its becoming stuck in the valve guide will cause loss of power through poor compression.

Of course there are other defects, such as leaks around the igniter, worn or loose piston rings, etc., which will cause weak compression, but the principal loss comes from leaky valves, especially the exhaust valve; and for this reason they should be carefully looked after, and tested frequently. When found to be leaking, the cages should be removed and the valves ground in. When grinding in a valve the work should not be considered complete until a bright surface appears all the way around on both the valves and the seat.

## LONDON LETTER

### GAS PRODUCERS FOR WOOD FUEL

By W. A. Tookey

BRITISH makers of gas producers have been engaged for the last year or two in conducting experiments, having for their object the evolution of a suction gas producer that will satisfactorily gasify the sweepings of saw mills and joinery works, and thus enable the proprietors of such factories to obtain power at little cost while keeping their machines clear of the waste that is frequently so difficult to dispose of.

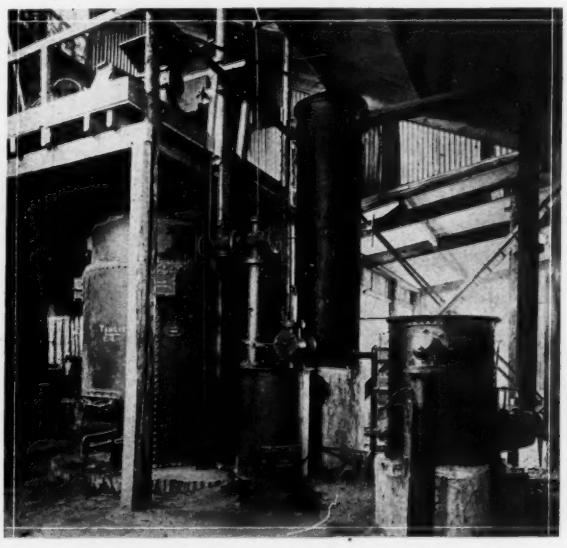


FIG. 2. TANGYE GAS PRODUCER USING WOOD FUEL

Some of the plants already at work are not quite the success that had been expected. The formation of acetic acid and the glutinous properties of the tar passing over with the gas from the generator have caused trouble and in not a few cases the makers have found that the circumstances obtaining in individual installations both with respect to the class of attendance and the grade of material, as well as its size, have necessitated a special treatment and, in some cases, radical alteration of the plant as originally erected.

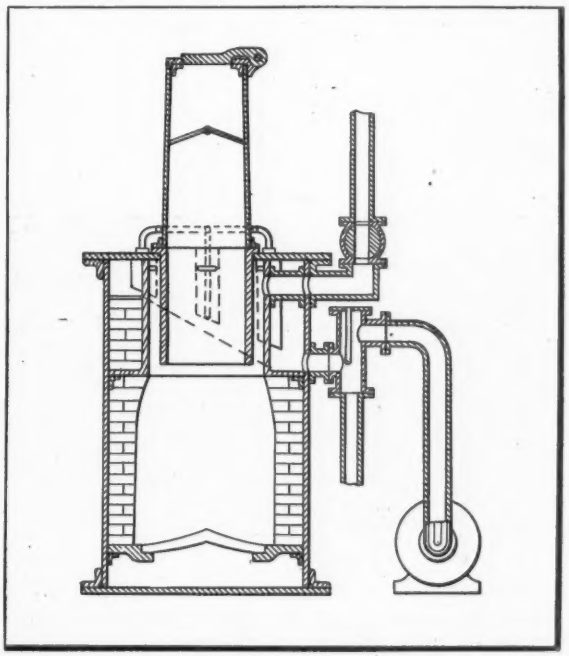


FIG. I. DIAGRAM OF WOOD GAS PRODUCER

In one such instance, the engineer of a sawmill took over a plant that was unsatisfactory and set to work to carry out his own ideas upon the subject and his efforts were rewarded with such success that he has patented several interesting features that it is one of the objects of this article to describe. The generator was originally designed upon the lines of an ordinary up-draft producer suitable for burning anthracite, but of course with larger furnace area because of the lighter material and the necessity of avoiding excessive velocity of the air through the bed of incandescent fuel.

It was found that the gas as it passed through apertures provided in the upper portion of the generator, on its way to the purifying apparatus, deposited tar in restricted ports which were difficult of access and the first thing that called for alteration was the provision of plenty of cleaning holes so that tools could be inserted to keep all passages clear. Then, in place of the water vaporiser that was fitted above the furnace and which was not really required owing to the great amount of moisture contained in the green fuel, which sufficiently humidified the air blast, a new top was fitted, with a sloping base, so that a number of water jets could play upon the gas as it passed from the furnace chamber. The water admitted at this point, drenched the gas, bringing down the acetic acid to a state of dilution that prevented it having detrimental effect upon the metallic surfaces, and also condensed the greater portion of the tarry vapors, which mixing with the water vapor created by the heat of the gases were thus washed out and diverted to the drains in the early stages of purification.

The partially purified and cooled gas was then conducted to a centrifugal tar extractor or beater, which whirling the gas at high velocity caused all the heavy particles entrained in it to be projected against the sides of the casing of the apparatus, a further supply of water being provided to enable the process to be carried out more efficiently. From the tar extractor the gas was led to a final purifier in the shape of a sawdust scrubber and dryer and thence to the engine. The more important parts of the apparatus are shown diagramatically in the accompanying illustration.

Since the alterations to the original plant have been successfully accomplished, many new installations based upon the experience obtained have been erected which embody the essential features with greater simplicity of construction than was possible with the

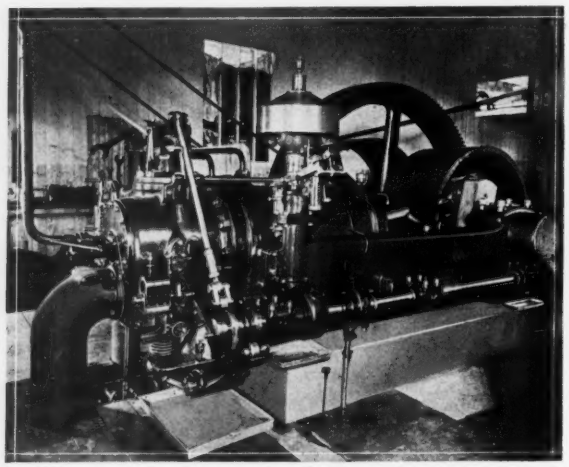


FIG. 3. TANGYE PRODUCER GAS ENGINE

original outfit. In every case success has been achieved and the producers are working under the management of ordinary mill hands and giving no trouble whatever. All kinds of waste wood appear to be gasified with the greatest ease and when necessary even sawdust itself can be burnt. The only difference in construction required for the latter fuel is to insure that the depth should not be excessive and that a long feeding hopper should be fitted within which fuel can be slowly dried as it falls gradually downward to the active zone of combustion.

The quality of the gas obtained is such that the engine will give out more power than is possible to obtain when using anthracite as fuel, the sawdust can be seen falling down slightly at each impulse taken by the engine and the combustion is so perfect that very little ash is left to be removed after a day's work.

Another type of producer designed to work with wood scraps, but not with sawdust solely, is shown in the accompanying photographs which represent an engine and producer constructed by Tangyes Limited of Birmingham. As will be seen, the gas producing apparatus consists of a generator, dust collecting chamber, coke scrubber, centrifugal tar extractor driven from a convenient main shaft, and a sawdust purifier or dryer. The charging platform is at a considerable height above the ground level, the feeding hopper being a long tube capable of holding sufficient material for 2 or 3 hr. of continued operation at full load. At each change of direction of the gas between the various pieces of the apparatus up to the inlet to the scrubber, clearing plates, operated by long rods through special flanges, are provided so that, in case of an obstruction occurring during work, the passages can be effectually cleaned without causing stoppage of the engine.

The engine illustrated is one of Tangyes latest types with throttle governing, details of which have been already given in preceding articles.

One of the simplest gas plants designed for the utilization of wood scraps and particularly for sawdust only is shown in Fig. 4. This operates upon the down-draft principle once the plant has been got under way, but is first lighted and worked by pressure from the ordinary starting hand fan as an up-draft producer.

The admission of air at the upper portion of the generator through the pipe shown, enables the charging arrangements to be greatly simplified, only a swinging cover being provided instead of the lid and valve, or rotating device usually fitted to suction gas producers. This not only cheapens the construction but makes the process of filling a very simple one in that no jamming of the fuel can take place. The air tubes descend from the hopper plate and terminate a short distance above the firebars so as to limit the depth of the active portion of the furnace, and the firebricks and grate are specially shaped to retain an uniform depth of fire throughout the whole of the grate area.

The upper portion of the generator acts as a distilling and drying chamber for the freshly charged fuel, the products of distillation, moisture and tarry vapors have no other outlet than through the intensest part of the furnace where they are decomposed and converted into fixed gases. It is claimed that only

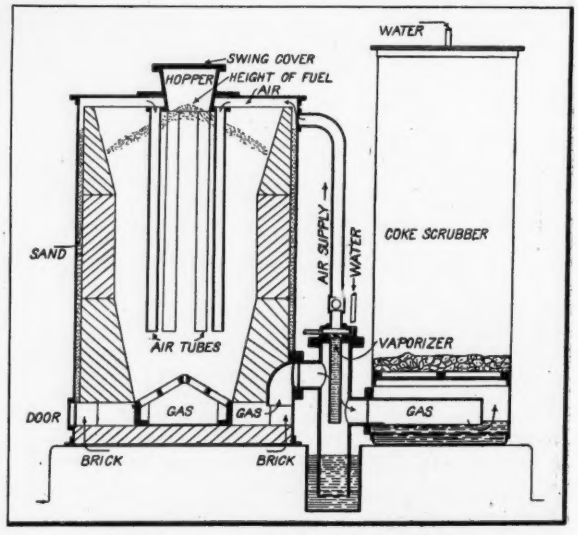



FIG. 4. SAWDUST GAS PRODUCER

traces of tarry matters are to be found in the gas passing from the base of the generator through the outlet pipe shown. On its way to the ordinary type of coke scrubber, the gas is made to come in contact with a tube filled with water and some of the heat is thus utilized in generating a small amount of water vapor for admission with the air blast if it be found necessary. The water tube referred to acts also as a dust separator as the heavier particles drawn along with the gas come into contact with the tube and fall into the drain pot while the gas passes into the scrubber through a slight water seal.

# FIRING MARINE BOILERS TO AVOID MAKING DENSE SMOKE

## RECOMMENDATIONS MADE BY THE SMOKE INSPECTION DEPARTMENT OF THE CITY OF CHICAGO TO BOATS USING THE CHICAGO RIVER

THESE recommendations were compiled by Smoke Inspector Osborn Monnett, acting in conjunction with his marine deputy inspector, Edwin F. Oyster, and while the advice is given as definitely as possible, in some instances he states that a little deviation may bring better results. The instructions are, however, so general that boats having either Scotch marine or fire-box boilers can use them to advantage in the effort to eliminate the formation of smoke and increase the efficiency of combustion.

### Coming into Port

FIRES should be cleaned before reaching Chicago, and before entering the harbor the fuel should be shoved to the rear of the grates clearing about 2 ft. of the front grate surface; the burning fuel should be covered with about 4 in. of fresh coal, and the cleared space filled with broken coal, almost to the top of the furnace, leaving the door cracked for a short interval, and putting on the blower. All fires should then be in the condition shown in Fig. 1 when about to enter the mouth of the river, so that the vessel will be

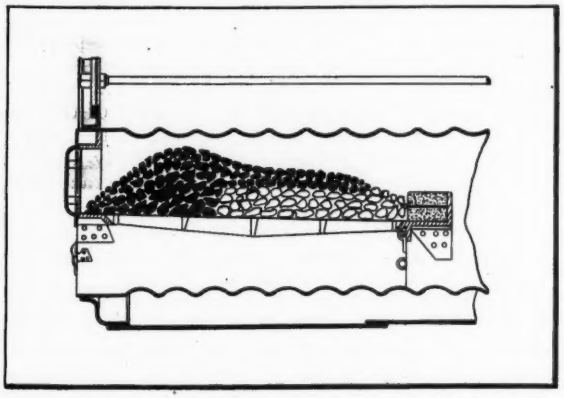


FIG. 1. FIRES IN CONDITION TO ENTER HARBOR, COAL COKING

able to reach the docks without again working the fires. Boats which must fire while in the Chicago River should use Pocahontas coal.

### On the River

WHEN steam is required at the dock or fire on the rear of the grates gets low, the coked coal should be pushed back and the front of the furnace quickly charged with fresh coal as before, leaving the door cracked for a short time, and keeping the blower on until the top of the fire becomes bright red. The steam pressure should be regulated by the use of the damper. Figure 2 shows the fire ready to be pushed back; Fig. 3 after the coked coal has been pushed back. This is the method to be used in firing when tied up at the dock or when working on the river.

### In Port

CLEANING of fires in port should be avoided if possible, but if it becomes necessary they should be cleaned quickly, and when possible only one boiler during an hour. Broken coal should be thrown in the front wings of the furnace on each side for a distance of 3 or 4 ft. the front door cracked and the blower put into use. Then wait until the last charge of coal is burning well, close the ash pit door and rake out in front all the old fuel on the central portion of the grate. Fill the cleared space with well broken up coal to a thickness of 4 or 5 in. and if steam is not immediately required, let the green fuel catch and get well coked from the live beds at the side.

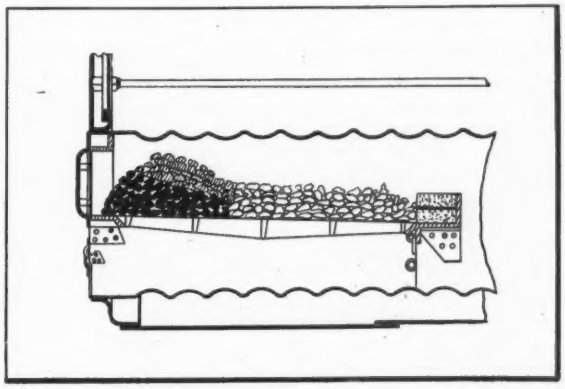


FIG. 2. COAL COKED READY TO PUSH BACK

If it is necessary to raise steam more quickly, the burning fuel on the sides can be winged over on top of the green coal, and after this or the previous operation, the ash pit door should be opened and the blower put on until the fire gets action.

When the middle portion has ignited well, rake out the sides which will be nearly burned out; then charge with fresh broken up coal, and allow this to burn

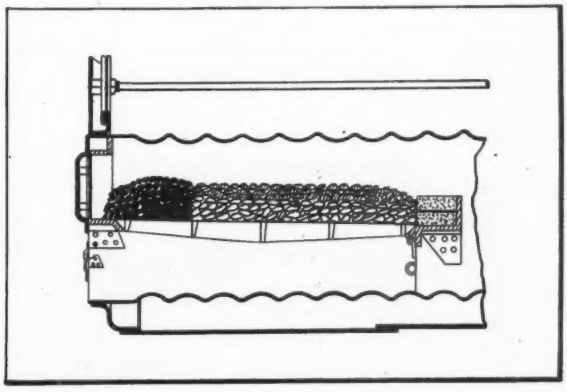


FIG. 3. AFTER COKED COAL HAS BEEN PUSHED BACK

without winging over the center, cracking the doors and using the blower. Figure 4 shows the condition of the fire when cleaning by the method recommended for cleaning in port. A is the central portion of the grate after being cleaned out and charged with coal, and B shows the wings of the furnace cleaned and charged with fresh coal, the central part of the grate being covered with burning fuel.

Plenty of time should be given after this method of firing for the fresh coal to coke before again disturbing the fires, and all cleaning and charging should be done as quickly as possible in order to keep up the furnace temperature.

### Firing While Shifting in the River

BEFORE getting under way, a half hour's notice or more should be given the fireman, so that he may have steam enough to shift without forcing the fires. Steam should be raised by stirring the top part of the fire with a rake and breaking up the coked portion of the fuel bed, at the same time cracking the door and using the blower. The fire should be allowed to burn brightly for a few minutes, then pushed back, and a new charge put on the front of the grate. This should be repeated as often as is necessary to hold steam.

To make additional steam while shifting, fuel beds may be barred if necessary, but this should consist

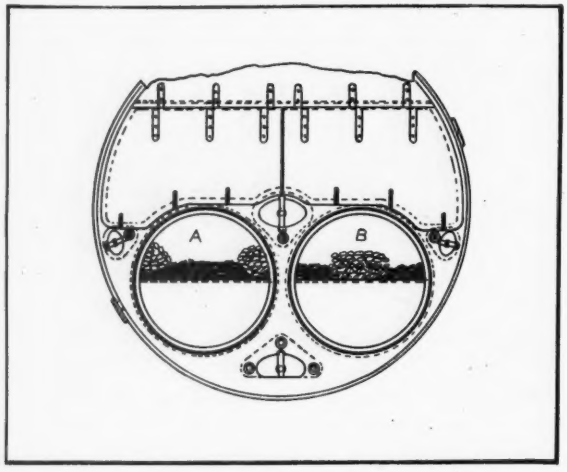



FIG. 4. WING METHOD OF COKING. A, CENTRAL PORTION OF GRATE HAS BEEN CLEANED AND CHARGED. B, WINGS CLEANED AND CHARGED, AFTER CENTRAL PART HAS BEEN IGNITED

only of a slight raising of the bed, and not passing the bar up through it, as clinkers would mix up with the fuel, spoiling the fire and making smoke. Figure 5

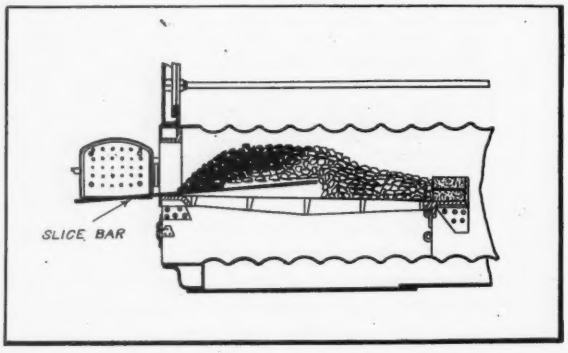



FIG. 5. CORRECT METHOD OF BARRING FIRES WHILE IN THE RIVER

shows the correct method of barring the fire under these conditions.

When charging the furnace the lumps of fuel should never be larger than one's fist. Cracking the doors consists in the doors being opened not over 1 in. and as they are opened for short periods only, the flues should not be affected. While in the river, fires should be carried very thick at all times, as if fires are allowed to burn down to 3 or 4 in. at the dock, it will be impossible to make steam without making smoke.

### Starting Fires

COVER the bare grate with well broken up coal to an average thickness of about 4 in. and then put 5 scoops of live coal on top at the bridge wall, as shown in Fig. 6; close the fire door and leave the damper open. Fire will then burn from the back to the front with much less smoke than by any other method as the

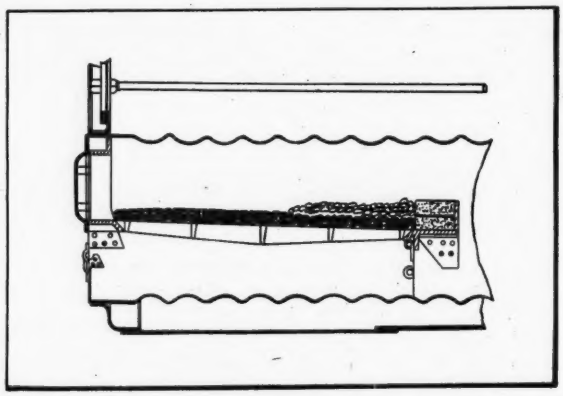


FIG. 6. METHOD OF STARTING FRESH FIRE

gases distilled off from the fresh coal will pass over the hot fire bed and be ignited.

When fire has covered the entire grate, push the fuel bed toward the rear, and fill the front of the grate with fresh coal, about half the height of the furnace. This should be left undisturbed until nearly all coked, and meantime the front door should be cracked and the blower used. When the coal is coked, shove it back, and repeat the operation as often as is necessary to raise steam. Figures 2 and 3 show the different stages in firing by this method.

In all operations where the fire is disturbed, give the fire a little air through the doors, and use the blower. In burning Pocahontas coal, which cakes quite easily, in order to get the required steam, the coal must be broken up occasionally from the top using a rake or hoe. Flues should never be blown in the Chicago River.

## BELT VS. ROPE DRIVE

By Richard Howarth

IN THE September issue, under the title Belt vs. Rope Drive, was a request for information upon which is the best for driving. Personally I prefer the rope drive when it is on the multiple or English system, that is, separate ropes for each groove. In this method there is no shut down if 1 or 2 ropes happen to be out of commission. I operated a 1500-hp. vertical Corliss compound engine for 2 yr. which employed rope drive with a 15-ft. flywheel grooved for 34 ropes, 1¾ in. in diameter and was run at 84 r. p. m. At this speed the velocity of the rope was 3958.4 ft. a minute and each rope was required to transmit 44.12 hp.

These ropes were put on when the engine was new, 16 yr. ago, and when I left 2 yr. ago they looked good for many years to come. In all these years, no repairs or renewals whatever have been made. They were lubricated

twice a week with a lubricant which we made ourselves of 10 parts of flake graphite and 1 part of molasses which formed a stiff paste and was rubbed on the ropes by hand.

Three years ago I was asked to go to a plant to replace 3 ropes with new ones. Old ropes had run for 28 yr. on an average of 12 hr. a day, 7 days a week, under heavy load. A total of 858.48 hr. of running at a velocity of 4700 ft. a min.

To obtain the best service from a rope drive the design of the groove should be about as shown in Fig. 1, which is in universal use in England and it gives good results. The 3-strand rope gives best results as it naturally fits the 45 deg. groove. The objection to the 4-strand rope is that, to make it, they have to put a small rope in the center and in splicing, this is cut out and the ends brought together, and after it has run a few days the rope stretches leaving a vacant space in the center of the splice which causes the rope to get in bad condition. This has a tendency to cause the rope to revolve around in the groove making a large amount of slip.

Rope drive has a further advantage in that width for width a grooved pulley will transmit more power than a smooth belt pulley because in the grooved pulley there is no cushion of air formed which is the cause of considerable slip with belts.

If properly laid out a 3 or 4-story mill can be driven direct from the flywheel of the engine with rope drive without a jack shaft or vertical shaft which is so troublesome with necessary spur gears. The limiting angle of rope incline for best driving is 45 deg. One of the merits of rope driving is the absence of noise.

The rule for determining the smallest size of pulley advisable to use is to multiply the square of the circumference of the rope in inches by 3; this gives the diameter of the smallest pulley, the larger the pulley the better the results.

The following table showing the strength and elongation of different kinds of ropes used for transmitting

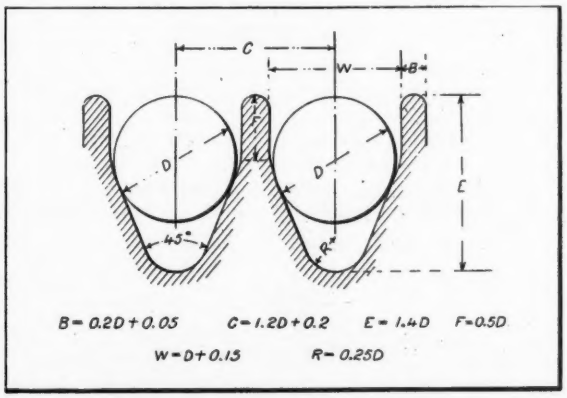



FIG. 1. PROPORTIONS OF GROOVE IN WHEEL FOR ROPE DRIVE

power is of value in laying out a transmission system. The values given are the results of tests made upon specimens 13 ft. long with the ends wound on grooved pulleys.

AVERAGE TENSILE STRENGTH OF ROPES

| | Elongation | Lb. per sq. in. |
|---|---|---|
| White Hemp ..... | 18% | 10,500 to 11,200 |
| Tarred Hemp ..... | 16% | 7,700 to 8,400 |
| White Manila ..... | 15% | 9,800 to 10,600 |

The tension per sq. in. of cross section allowable for rope is 200 to 300 lb. for long life, this, of course, allows for centrifugal tension. It should be noted that at high speed the tension available for transmission of power is considerably reduced due to the centrifugal force of the rope throwing it away from the pulley. The maximum speed advisable is about 4800 ft. a minute. Above this speed the centrifugal force increases at a faster rate than the power due to the increased velocity of the rope. To take this into account the working tension of the rope must be decreased by an amount in pounds equal to the weight per foot of the rope times the square of the velocity in feet a minute divided by 32.

The allowable stress per rope including centrifugal force is about 160 times the square of the diameter of the

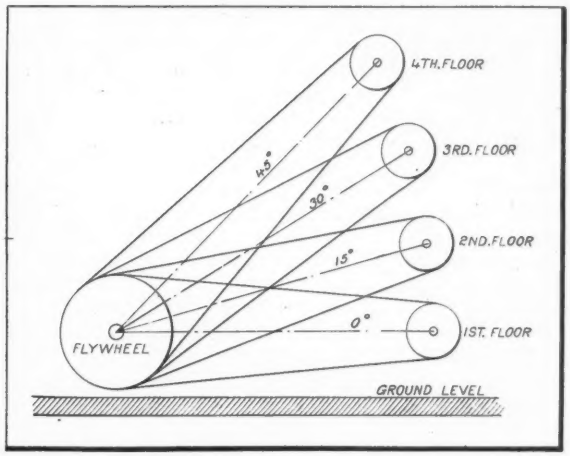



FIG. 2. ROPE DRIVE TO FOUR FLOORS OF MILL

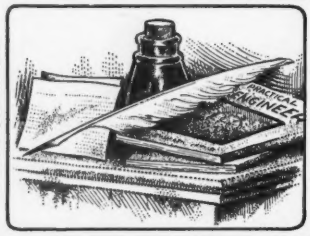
rope in inches, the result being the pounds stress This corresponds to a stress of about 200 lb. per sq. in. of section.

The largest rope drive of which the writer is aware has a single pulley of 64 ¾-in. ropes delivering 4000 hp. in a cotton mill in Lancashire, England.

The life of a rope drive depends on its make, the condition and shape of the groove, the tension and many other points depending upon condition of service so that no hard and fast rule can be laid down. Many drives, to the writers' knowledge have been running over 20 yr. with perfect satisfaction. Hemp ropes, although stronger than cotton, do not stand so well as cotton. Approximate horse-power of hemp rope is equal to the circumference in inches multiplied by the diameter of the driving pulley in feet, times the revolutions per minute, all divided by 200. Another rule is to multiply the square of the circumference of the rope in inches by the velocity in feet per minute times one less than the number of ropes on the pulley and divided by 5000, the result being horsepower.

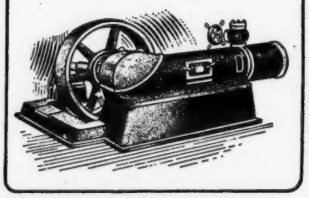
Cotton ropes at a speed of 2500 ft. a minute will transmit horsepower equal to the square of the circumference of the rope in inches, multiplied by 12. Cotton rope 1¾ in. in diameter and weighing 1 lb. per ft, at a velocity of 5000 ft. a minute will transmit 50 hp. Ample space should be allowed in a rope race as this adds to the life of the drive.

Long splicing is absolutely necessary to the life and satisfactory operation of the rope, and when having new ropes to put on, it is well to secure the service of an expert to splice them, as from the writer's personal experience three-fourths of the trouble experienced with rope drives is from bad splicing. The length of splicing on 1¾-in. rope should be 5 ft. from each end. A good rule is to measure off 40 diameters of the rope to be spliced from each end and tie strings around at these points. All ropes should be stretched with a pair of chain blocks and left stretched all night before using.



# Letters from Engineers

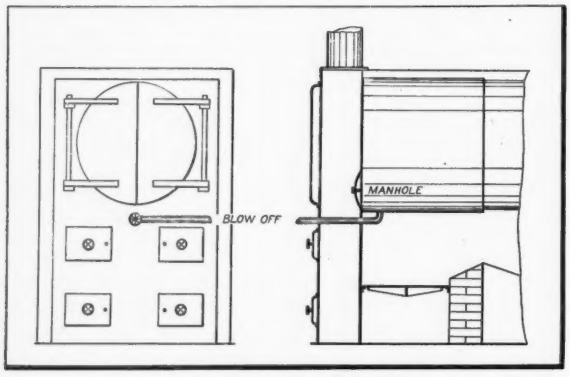
**Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings**



## BLOW-OFF PECULIARITIES

WHEN reading over the various scientific papers relating to modern methods of the installation and building over of steam plants we often observe numerous articles relating to the proper method of installing blow-off pipes, and while reading such an article quite recently it recalled to mind a rather unique arrangement that came to my notice some time ago in which the blow-off was installed in front of the boiler. This rig was the first, and in fact, the only one that I ever saw of this description, and appealed to me as having several good points notwithstanding the fact that it was directly in opposition to the general rule.

This boiler was set with a pitch of 1 in. to the foot towards the front end and the blow-off was placed at this lowest point and consisted of an ell with a close




BLOW-OFF ARRANGEMENT

nipple about 4 in. long between the top of the pipe and the shell. The pipe extended out through the front and the angle valve was placed right over the fire doors and the pipe then ran across the front and out to the blow-off well. The points that were brought to my notice were these: In the first place the length of pipe exposed to the action of the gases is a great deal less than if it were at the rear; another point is that when blowing down a boiler with the blow-off at the rear it is almost always a matter of guess work as to how much is being blown out owing to the fact that the glass water gage is not in a position to be observed, and so consequently it either has to be guessed at or the blow-off left open while the operator goes around to the front to see the glass. And there have been cases known when the operator's attention has been attracted in other directions and the boiler has been blown dry and consequently ruined. In this case when the blow-off was located in front the water gage was in plain sight, thereby allowing the operator to know just how much was being blown out. Another point was that if at any time it became necessary to install a new pipe it was a great deal easier to get at the pipe.

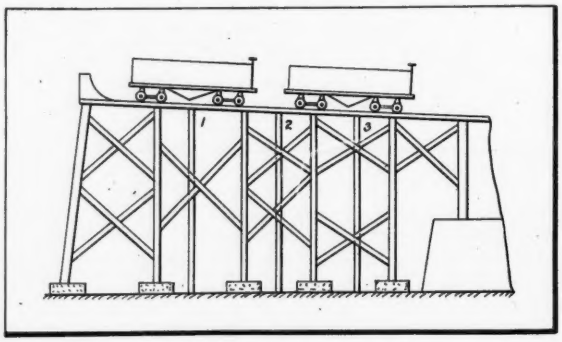
Realizing that this place in the boiler (right over the fire) had always been considered to be the hottest part of the shell with tubular boiler, I inquired if any trouble had been encountered from this source and was informed that the boiler had been in for a period of 5 yr. and the original pipe was still in use. I also learned that there were no handhole plates in the rear of the boiler, but a manhole plate was provided in the front, 11 by 15 in. This means enabled the attendant to enter the boiler at the bottom and he could crawl all along the bottom of the shell to the rear if necessary. This also appealed to me as being a good idea, for there is nothing so exasperating and so conducive to bad words as to have to stand up in a combustion chamber, when the temperature is about 190 deg., to cut off the nut that is burned on the stem of a handhole plate. A 5 by 7-in. handhole plate was, however, provided in the steam space at the back, above the tubes and high enough to be above the arch on top of the combustion chamber, and so was accessible at all times. There was no handhole plate to leak after the boiler had been filled up and steam raised necessitating cooling the boiler down to screw up the plate (and this is a common occurrence) as the plates are always accessible and could be taken up gradually as the pressure increased. The rig was not according to theoretical ideas, but to my mind it possessed some good practical points.

Chas. H. Taylor.

## COAL STORAGE

THE company for which I work formerly stored coal in the mill yard close to the boiler room, and as they make a fine grade of linen paper one can readily see that it would be better for their finished product to store the coal farther from the mill.

With this end in view they bought a strip of land adjoining the railroad and put up a trestle shown in




TRESTLE FOR COAL STORAGE

the sketch. This made a convenient dump that had a capacity of about 40,000 tons if they ever wished to fill it, but the general practice was to put in enough each fall to carry them the following year, hauling it to the mill every day as it was needed.

As a precaution against fire they put in square wooden tubes, 1, 2 and 3, so when the pile was large they could drop a thermometer down and get the temperature at the bottom of any part of the pile.

For the first year or 2 the thermometers were worked overtime, but as the dreaded spontaneous combustion failed to present itself they gradually fell into disuse and the tubes became filled with coal.

About a week ago the coal shovelers reported the pile on fire, and then they tried to locate the hottest part of the fire, but the wooden tubes were out of business.

They dug down in different places and put a stream of water on it, but it is still burning and as they uncover the trestle it shows the pine framework has turned into a fine grade of charcoal.

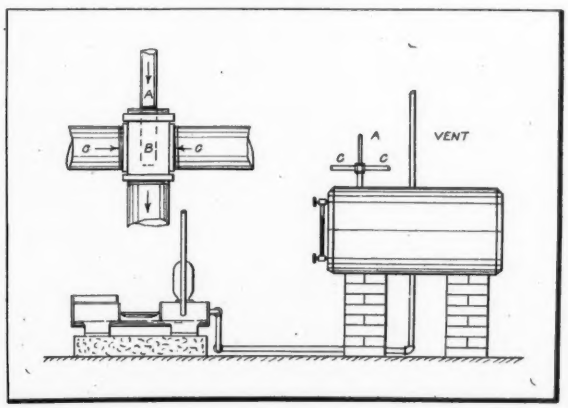
Where the fire has been uncovered it shows a roof of solid coke that water will not go through and this has to be broken before the stream can reach the fire. When they get the fire out they intend to protect the trestle piers with concrete and in place of the tubes, 1, 2 and 3 use a perforated iron pipe to get the temperature and be able to flood the pile at any time.

A. W. Griswold.

## RETURN TANK OF HEATING SYSTEM

IN SCHOOL buildings and hospitals, where heating and ventilating apparatus are installed, the boilers are fed by the way of the receiving tank and return pump from main heaters or blast coils at fans, drips from high and low-pressure piping which are free from oil are tapped into a vented receiver, and from here pumped back in boiler.

Fresh water which is required to replace that lost by the various wastes and used to condense the exhaust steam enters the ejector at A, and passes down through nozzle B. This action insures a rapid condensation. The exhaust steam and the condensation from returns enters C with comparatively high velocity, is drawn into receiving tank and from there pumped into the boilers with return water. This fresh water supply may be admitted to the tank either by a hand valve from city water supply or by an automatic boiler feeder. In the former case the admission valve should be opened just enough so the stream flowing continuously will maintain a constant level in the receiver, rather than to admit large quantities of cold water intermittently. A hand valve in the supply pipe can usually be set to maintain the line closely when the plant is running under uniform conditions.




CONNECTIONS FOR RETURN TANK OF HEATING SYSTEM

It is essential to place a boiler feed pump in such a position that, where the water is very hot, it will flow to the pump by gravity or under pressure, and it is possible to maintain a better vacuum in the receiver, being very careful to maintain a constant level in the receiver. Otherwise the water will draw in either vapor or a mixture of vapor and water.

Louis A. Danner.

## IMPROVEMENTS IN A PLANT

WHILE on my vacation recently, I went to visit a power station where I used to work and found one of the former assistant engineers filling the position as chief engineer. When looking over the station, I noticed the firemen were not shutting the ash pit doors when steam was up and load happened to drop off, and also the safety valves were not blowing like they formerly were. I asked him what he had done to the damper, and he said, "Nothing, only fixed the big hand damper in the by-pass smoke flue under the economizer."

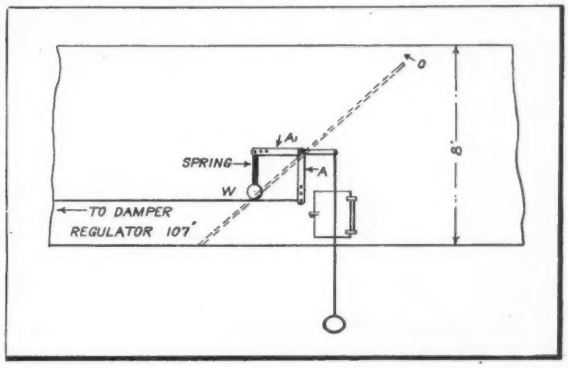



FIG. I. ORIGINAL DAMPER ARRANGEMENT WITH REVISED REGULATOR ATTACHMENT

As there was no way to get at it, he cut a piece out of the side of smoke flue and put in a door; he found the damper had been put in wrong side up so that it was suspended from the straps and rods that served as pivots for damper to swing on. Some of the nuts were off the bolts and some bolts pulled through, so that the rods were bent and damper did not close at top by 10 in., as shown at 0 Fig. 1. He had heavier straps made and turned the damper over, and when put up in place it closed tight at top and bottom and had remained so since.

The damper regulator was connected to the main damper in outlet from the economizer and when that was cut out for cleaning or repairs the regulator was of no service, and the firemen would regulate the draft by the ash pit doors; so he had a bell crank made from ½ by 2-in. flat iron and put it on the shaft of the hand damper of by-pass, A A, Fig. 1, and connected the regulator to it by means of heavy wire with small chains and pulleys at the corners, the regulator will open damper by pulling on liner A, and the weight W will close the damper when regulator closes.

On the lever of the damper regulator he had put a dash-pot—a home-made contrivance, Fig. 2, and filled it with oil. He explained that it stopped the tettering of the lever and reduced the wear on the balancing knife edges to a very small amount.

The safety valves he had ground in and kept them adjusted to blow at the proper pressure, and only blow back 3 lb., and told the firemen that he did not

want to hear them blow only when they were tested each day. I asked him if he was saving much coal by the changes made. He said that he was; besides it made it easier for the firemen.

I saw one man filling up cracks in the brick work of boiler settings. He told me he used asbestos pipe covering cement mixed up with tar paint, and it gave the best results of anything he had been able to find.

The men were cleaning out the economizer, getting ready for inspection, and he showed me how he got the soot out. He had cut a hole in bottom of economizer and cemented in a flange with a 5-in. nipple extending through bottom, making a catch basin and drain, which is covered with an iron plate when economizer is in service. He fitted some old 6-in. pipe

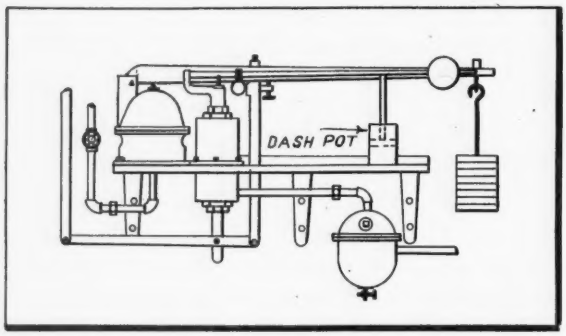



FIG. 2. DAMPER REGULATOR WITH DASH POT ATTACHED

over the end of nipple and ran it to the blow-off trench back of the boilers, that being drained to the river. After the economizer was cold the openings at side were closed up and a man with oil-skin suit and rubber boots took a 1½-in rubber hose and extension lamp and went in and washed everything down the drain pipe. In about half a day, he could clean it as clean as new and leave no muss in the boiler room either.

He also had laid drains in the boiler room floor with catch basins where water was likely to collect in front of boiler and around feed pumps. I often wonder why that is not done in more boiler rooms when they are installed, and sometimes when I think of the floods I have seen in boiler rooms from something springing a leak or from cleaning of boilers, I wish the man that was responsible for installing them had to work in them with wet feet for a while, then he would do better by the next one. C. C. C.

## CRITICISM ON CARDS FROM PUMPING ENGINE

THE cards submitted by W. P. F. in the October issue are so particularly typical of the engine described that the writer instantly recognized their origin before referring to the text, as probably did many engineers who have had experience with the old Gaskill compound pumping engine.

This engine is unique in design, the high-pressure cylinder being mounted directly over the low, the exhaust valves of the high being the admission valves of the low, no intermediate receiver being employed. The high-pressure piston completes its stroke as the low-pressure piston begins, one at the head end and one at the crank end of each of their respective cylinders. The high terminal and excessive back pressure in the high-pressure cylinder are characteristics of this engine as several sets of cards in the writer's possession will show. Perhaps this is one reason why this type of engine never startled the world with a new duty record, though its performances, considered from every other standpoint has been very creditable indeed, as the records of a great many of them, now operating in some of the largest municipalities in the country will attest.

In this type of engine it is evident that the high-pressure cylinder cannot rid itself of its exhaust steam any faster than the low-pressure will take it, and it appears manifestly impossible in this case to reduce the terminal pressure to conform with what is considered to be economical practice in the better class of compound engines, by any manipulation of the valves. It is to be regretted that the contributor did not send information as to the size and stroke of cylinders and plungers, steam pressure, vacuum, head in feet against which pump is discharging, scale of spring and other data as all engineers should do when submitting cards to the public press for criticism. In the present case there seems to be a disproportion of cylinders involved which would be a nice problem for the readers to work out were the information above mentioned at hand. I would suggest that the engineer in charge experiment by raising the boiler pressure to obtain a shorter cutoff and a more complete expansion in the high-pressure cylinder, which will decrease the initial in the low-pressure cylinder, thus obtaining more economical results by realizing a better use of the vacuum. The low-pressure exhaust valves should also be opened earlier so that exhaust will immediately drop to condenser pressure before the piston starts its return stroke.

In the steam lines of both the high-pressure cards it will be seen that the cutoff starts to take place, changes its mind, admits steam a little further and then really cuts off. The admission valves of this engine are of the double beat poppet type actuated by a beam lever, with a spring dash pot directly over the valve. The writer has found this trouble in the steam line to be caused by a "rebounding" poppet valve. The cutoff cam trips and the momentum seats the valve, but the momentum not being great enough to expel all of the air from the cushion chamber of the dashpot, the expansion of the remaining air raises the valve from its seat an instant for a slightly further admission when the air, slowly oozing out, finally allows the valve to seat I would suggest also that the engineer make sure his poppet valves are not leaking.

F. C. Holly.

## FLYWHEEL UNTRUTH

I HAVE some flywheel trouble that I would like discussed. The wheel is a plain wheel in 2 sections, it is 16 ft. in diameter with a 28-in. face, it is on a 20 by 42-in. Corliss engine and runs at 81 r.p.m. When I took charge of the plant 3 yr. ago I noticed that the wheel was loose and began trying to tighten it. I was informed that it had been loose for 3 yr.

There are 2 bolts 2½ in. on each side of the hub and 3 1⅛ in. on each side of the rim. I took the bolts out and heated them enough to expand them, and put them back and tightened them all that I thought they would stand. The wheel seemed to be tight for a while but soon began to work oil from under the hub, and crack when it was pulling a load, so I took the bolts and key out and had new bolts and key made as the old bolts were badly strained and the key was too thin. I warmed the new bolts and tightened them all that I thought they would stand, and after the bolts got cool I

drove the key in until it seemed to fit nicely. The wheel did not crack or make any noise for one year, but I could see a little oil working out from under the hub and now I can tighten the nuts a half turn every 6 or 8 weeks. The wheel is 3/8 in. out of true. Do readers think that this wheel is dangerous and what remedy should be used? E. L. Swearingen.

## PILOT VALVE ACTION

A STYLE of pilot valve, for high-pressure hydraulic elevators, that finds much favor in situations where the motor valve pressure is somewhat in excess of the ordinary, but which seems to have been overlooked by the authors of whatever literature pertains to the class of elevators in question, is shown in section in the accompanying Fig. 1. This is known as the plug type of pilot valve, and is formed by assembling a series of leather disks upon a brass thimble, the whole being compressed between the collars of the middle spool and followers as shown.

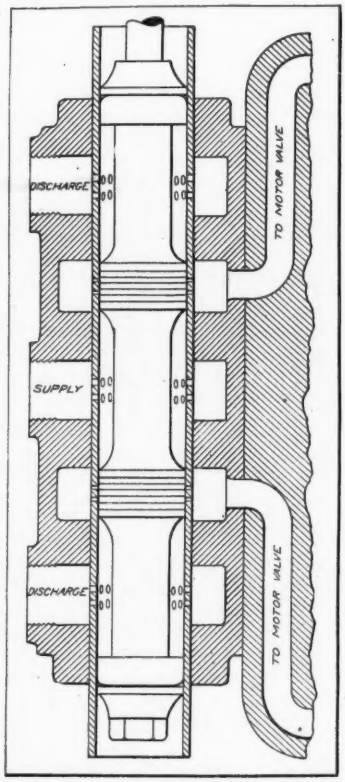



FIG. 1. PLUG TYPE PILOT VALVE

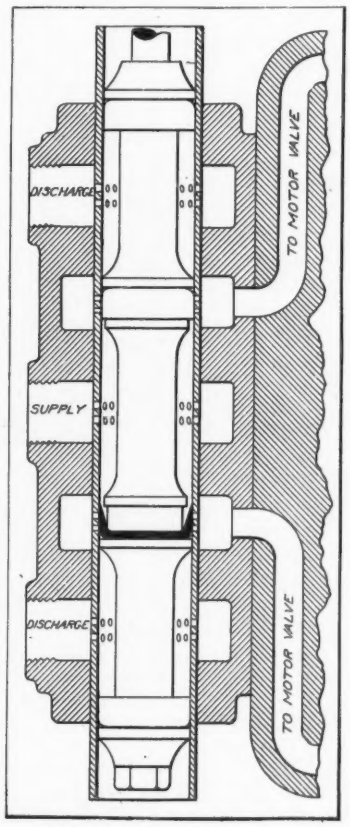



FIG. 2. CUP-LEATHER TYPE PILOT VALVE

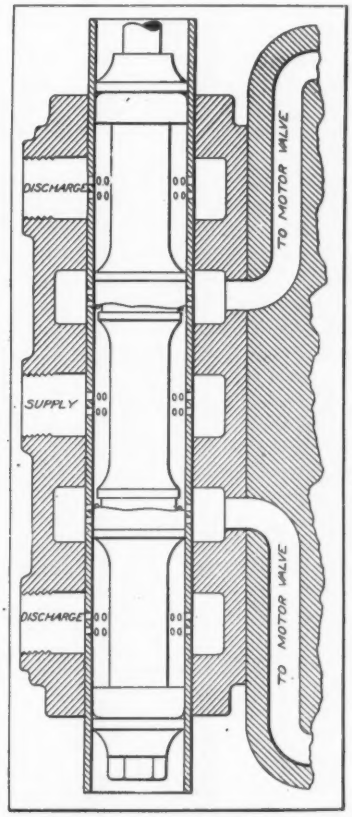



FIG. 3. CUP-LEATHER VALVE AFTER BEING IN USE

This type was, as a matter of fact, designed in the first place for especial use with elevator installations where the full accumulator pressure was used to actuate the motor valve, the pilot pump having been dispensed with.

While the construction shown produces a valve of permanent form, compact and rigid against distortion from stress of service, still it is objectionable on account of the trouble experienced in renewing the plugs, once they become worn out. The job of fitting the new disks must be done in the lathe, to be done properly; and even where an accurate running fit is thus obtained, much annoyance will almost invariably result from swelling of the leather and consequent sticking of the plugs when the valve is again put in service. Also, constant abrasion by the edges of the disks will, in the course of time, wear the brass sleeve to a slightly larger diameter along the portion of its bore in which the plugs operate, and thus a sluggish action of the motor valve, on account of leakage, will be produced; the inflexibility of the structure preventing the leather from following up the wear and thereby remaining tight.

With the cup-leather style of pilot valve, which is the one described in all treatises upon the high-pressure elevator, the difficulty here mentioned does not exist. But for reasons quite apparent, a pilot valve of this form is adaptable only where a comparatively low pressure is used to operate the motor valve.

On account of the facility with which the cups can be renewed, however, many engineers in plants where the plug valve is already installed, but where the pressure available for the motor valve is not so high as entirely to preclude the use of cup-leathers, prefer to substitute the latter for the leather disks. This is very easily done by reducing the collars of the middle spool and providing brass fillers for the cups, as indicated in the sectional view of the lower middle cup in Fig. 2.

This cup-leather device has one objectionable feature. When newly inserted, as in Fig. 2, the round heel of either cup will have completely uncovered the port for discharge from the corresponding end of the motor cylinder before the lip of its mate has begun to uncover the port for admission of pressure to the op-

posite end of the cylinder, the result being impulsive responses of the motor valve and sudden rapid starts of the car, when slow and deliberate movements through short distances are required. The valve illustrated in Fig. 1 entirely obviates this annoyance; because when properly adjusted the 2 plugs open the opposite ports in unison; the discharge opening being exactly equal to the inlet opening at all stages in the travel of the valve.

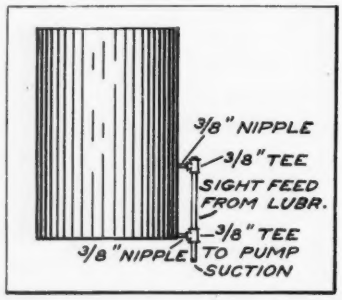
In the course of a few hours' service, however, the new cup leathers will usually become distorted to a form nearly or quite approaching that shown in Fig. 3; the lips receding and the rounded heels shaping into square shoulders. When the cups assume this shape, the apparatus loses its extreme sensitiveness; the action of the mechanism then approximating very nearly to that obtained with the plug value.

But as the cups lose their original contour, the inner annular series of perforations which lead at each end of the motor cylinder ports, become partly or quite uncovered when the pilot valve is central; thus permitting the pressure to impinge upon both faces of the motor valve. While this condition does not impair the function of the device in maintaining the motor valve in equilibrium, it might, nevertheless, be considered objectionable on account of the inevitable leakage both ways to the discharge outlets.

With the cups distorted in the manner indicated in Fig. 3, it is clear that motion of the motor valve will result simply from closure of the inner circle of holes at either end, and simultaneous opening of the outer circle, in consonance with the progress of the corresponding cup leather. A. J. Dixon.

## BOILER COMPOUND FEEDER

ACCOMPANYING is a rough sketch of a home-made boiler compound feeder, or crude oil feeder, which works perfectly. I have been using one over 2 years and would not be without it. All that is needed is a 2 or 5-gal. can, a few ⅜-in. pipe nipples and the sight feed glass connections off some old castaway lubricator. Where the pumps take their water supply out of an open heater all that is necessary is to place the compound feeder above the water level in the heater and run pipe connections to the suction pipe of pump.



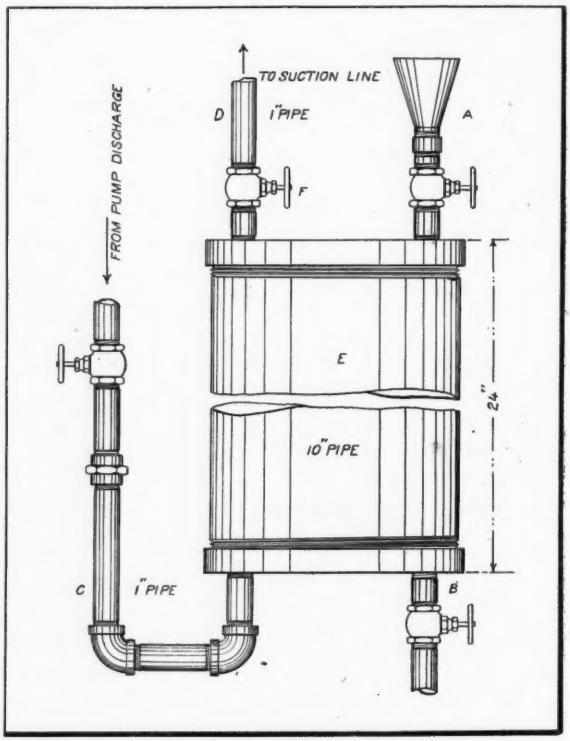

CRUDE OIL OR COMPOUND FEEDER

I was troubled a good deal with scale in my pumps. I had to chisel out the scale every week until I rigged up the feeder. It will keep the water end free from scale. Perhaps some may think that the compound will eat up the packing in the water end of the pump, but it never has destroyed any packing for me.

If all connections from the feeder are air-tight to suction connection, the feeder will not feed except when the pump is running. The faster the pump runs the more compound will be used, and with a little practice anyone can regulate it to a nicety.

Fred V. Broadaway.

PERHAPS some of the readers of Practical Engineer would like to know how to make a home-made boiler compound feeder which can be relied upon to give a uniform feed to the boilers whenever the pump is running. The accompanying sketch shows one made by the writer. E is a piece of 10-in. pipe 24 in.




HOME-MADE BOILER COMPOUND FEEDER

long with 2 caps, one for each end bored and tapped for 1-in. pipe connections, C and D may be ¼-in pipe. A is for filling, B for emptying, C is connected to the discharge of the pump line, and D is connected to the suction line. Regulation of the amount used is accomplished by means of the valve F. John Mitchell.

## LICENSE INJUSTICE

WHILE I was reading J. W. Nash's letter in Practical Engineer on the above subject, I thought of my own case, which proves the injustice of the license law in Massachusetts. I arrived in Boston on April 22, 1910, and looked for a situation. I was offered a situation near Attleboro, Mass., as second engineer and was told by the chief to go in for my license as second-class engineer, and as soon as I received it I could commence work. I never expected to have any trouble in passing the examination, nor did the chief, as in England I had been 12 yr. in charge as chief engineer of plants from 400 to 2500 hp. and was instructor in indicating and slide rule calculations to the members of the N. C. E. & F. Union at Burnley Branch. I am accustomed to valve setting in all its branches, and a. c. and d. c. electrical work. In due time I received my application blank, which I filled in, stating that I wanted to be examined for second-class engineer's license and returned it to the

examiners, and was requested to appear for examination at Fall River, Mass. In due course of time I went.

The examiner asked me if I was working, and I said no, but had a job offered me at a certain plant as assistant. "Have you ever held a Massachusetts license before?" I said, "No." He took me over to a small boiler, asked me about injector, fusible plug, etc. He then told me I would have to wait 90 days to apply for engineer's license and I would have to hold a fireman's license first. He gave me a first class fireman's license and turned me out.

Now I thought that it was the law in Massachusetts that a man must hold a fireman's license first before you could get an engineer's license. Of course I lost the job. Without a chance to get another without waiting 90 days, and having a wife and 3 children in England dependent upon me I looked around for a job and got one, firing 4 return tubular boilers for 12 hr. a day and handling 12 to 14 tons of coal a day, at a large salary of $12 a week of 6 days.

I had fired here for about 2 weeks when the engineer came in the fireroom and said he was going to indicate his engines and would like about 5 lb. more steam, as the figures looked better, he said. After he had taken off his cards he came to show them to me in the fireroom. I asked him if he could figure them out, he said no; still he held a second-class license. I showed him how to work them out, in several methods, and explained the expansion curves. He worked under a chief who held a special license, first-class, who could not even write his own name or read a word and had to send to Providence for a man to come and set the valves on the boiler feed pump. I soon left this place and started to fire elsewhere. I have done nothing else since, and was so disgusted with the license law that I will never apply again. I am in Rhode Island, a no-license state, and who can blame a man after the above experience.

Richard Howarth.

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## A TIGHT PIPE JOINT; EXHAUST PIPE

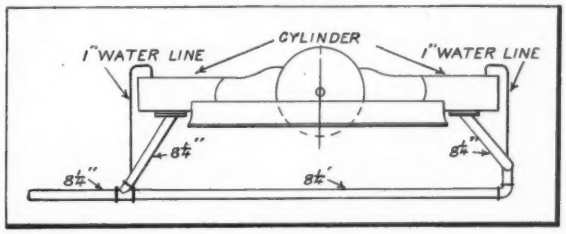
ON page 551 of the August issue, in an article by W. S. Luckenbach in regard to tight pipe connections, I am compelled to take exceptions to his statement in regard to making a tight joint. In the first place it is nearly impossible always to obtain fittings and pipe that the threads are not more or less porous, even in ammonia fittings, and in overcoming this difficulty I have found that to make a perfect joint the best way is to tin the threads with solder. This is not attacked by acid and in case of expansion the joint is always tight because lead expands faster than iron.

I put in my last plant 1800 ft. of 1, 1½ and 2-in. pipe which was subjected to high pressure and varying temperature. Each thread was cleaned and dipped in hot solder just before using. After the job was finished I had but one leak and that was from a sand hole. I may state further that in my experience of pipe fitting, I have always found that there is a limit to screwing pipe beyond which it does more damage than good. This is a fault commonly found among new and inexperienced fitters. I admit if the pipe and fittings were all mechanically perfect there would be no need of any mixtures for the threads, but such is not the case and we must meet the situation as it stands.

In reply to J. O. Benefiel's article in regard to exhaust pipe from gas engines, I would like to state that cast iron will outlast any wrought iron on the market if the water is not charged with acid. If this statement were not so, why should water companies use it for their mains?

I dismantled one station last summer that had been running night and day for 3 yr. It had 8¼-in. casing for exhaust pipes, which were 81½ ft. long, running from 3 150-hp. direct connected gas compressors working against a discharge pressure of 120 lb. having an intake of 10 in. of vacuum. This pipe I examined after it was taken out and failed to find any pitting or corrosion. In the writer's judgment more trouble in this line is caused by the man in charge of the plant, not looking after the kind of oil he uses. There are on the market gas engine oils which are not pure mineral oils, but compounded. A compound oil may work out all right in small engines, but in large engines where the temperature of the gases is high it gives poor satisfaction, according to my experience.

I have now under my charge 5 165-hp. and 2 150-hp. engines of the 2-cycle type using 8¼-in. casing and 8¼-in. fittings for the exhaust, connected like the accompanying drawing. By running the jacket water into the exhaust pipe it deadens the noise and makes the




EXHAUST PIPE ARRANGEMENT

exhaust sound like a steam engine and cannot be heard over 500 ft. away. By taking the water out of the exhaust when the engines are working under full load they have been heard 7 miles from the station and one standing near the plant would think that a battery of artillery had cut loose. If Mr. Benefiel will look to the oil proposition and then determine if the water becomes charged with the acids expelled from the cylinders caused by the decomposition of the animal oils, he may find his trouble.

Mineral oil, such as produced from oil wells is considered the best oil to be used in a cylinder. Oils compounded with animal and vegetable oils possess certain properties which make them totally unfit for a gas engine cylinder. They decompose easily and if the atmosphere is warm and moist, the decomposition becomes greatly hastened. These conditions of heat and moisture exist in every gas engine cylinder to a certain extent, therefore the use of these oils must be regarded as contrary to good practice. Let us note just what takes place when either of these 2 oils is used in the cylinder compound.

Tallow contains a compound of stearic acid or a stearine compound of carbon, hydrogen and oxygen. When it meets with steam or hot water the action of the heat decomposes the tallow to a certain extent and a portion of the disassociated atoms combined with a portion of the hydrogen and oxygen of the water form new compounds, so that where originally there were stearine and water, there is now stearine acid and glycerine. This stearic acid being in a free state, is now left to attack the metal, which it does with great vigor. The same thing would take place if palm, vegetable or lard oil is used. Palm oil gives off palmic acid and from the lard and vegetable oil we get oleric acid set free. both of these acids will attack metal of an engine or exhaust line.

L. E. Conroy.

## OPEN JOINT IN FLAT COOLER

WE had trouble getting good ice in our plant; it would come out white, the water looked clear, the reboilers worked perfectly. We sent for an expert from the factory, but yet did not get any better results, the ice continuing to taste badly. Finally, one night one of my deep well pumps broke down and I had to use river water over my flat cooler. Being muddy, I soon had muddy water coming through into my forecooler, and then I discovered an open joint in the flat cooler. As there is salt in the deep wells, the cause of the disagreeable taste was found. After fixing the flat cooler I have had no further trouble. C. J. Mayer.

## A PERSISTENT KNOCK

WE sometimes run across a condition in our steam engine running that is hard to master and the one shown in this example is of the kind that is hard to get rid of. The knock was caused by an untrue

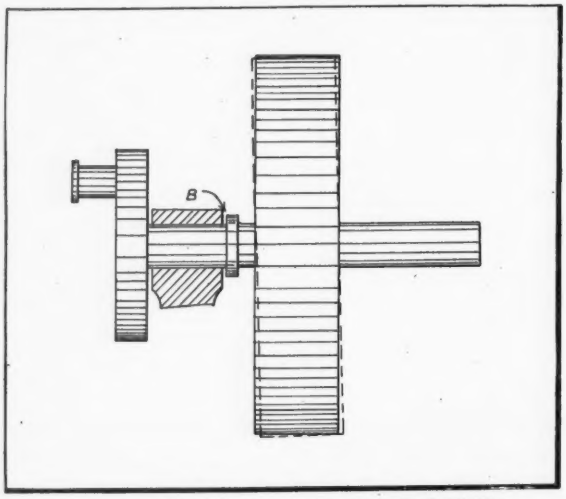



FIG. 1. FLYWHEEL WHICH CAUSED KNOCK

flywheel, or a wheel that was thrown out in keying, and this engine had a continual knock. All means were resorted to to rid the knock, but without success. The wabble of the wheel caused the shaft to shift back

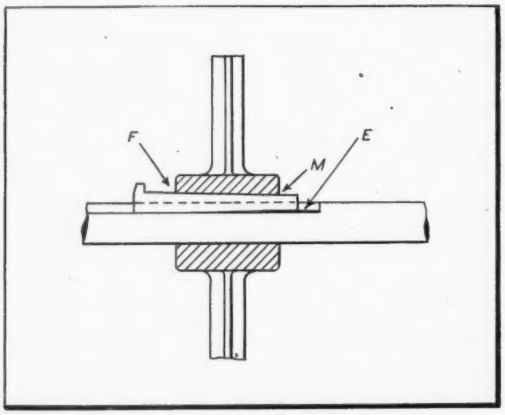



FIG. 2. SETTING OF KEY TO STRAIGHTEN WHEEL

and forth and bring the collar against the bearing at B, which had a slight play, and caused a dead sound in the engine.

I have straightened several wheels by removing the key and putting a thin liner beneath the point of the key, as shown at E, and by redriving the key it will bring more pressure to bear on the point M, and by careful work the wheel can be set straight on the shaft and made to run true. The wheel having more play than it should have, and the key being driven with the binding point bringing more pressure on the hub at F cants the wheel and causes it to run out of true.

C. R. McGahey.

## WHAT TO DO IN EMERGENCIES

I HAVE been much interested in the recent article wherein Mr. Wakeman replies to P. C. V. Mr. Wakeman says there are kinds of Corliss engines that do not use the wrist plate gear on the valve motions, which is true. He also states that there are other ways of getting steam into an engine to start it besides rocking the wrist plate to pick up valves, but does not say how. Now perhaps that is just the point P. C. V. is stuck on; simple enough to one who knows, but not to a beginner.

Why would it not be a good idea for an engineer who has anything unusual happen in his engine room, to write out the instance plainly in the shape of a question, and ask, "What would you do in a case like this?" It would tend to bring out answers and experiences wherein young engineers, and perhaps some older ones, would get pointers on all classes of work that they will not find in text books. What to do in an emergency, and do it quick, is the test of the ability of an engineer.

I will give 2 instances that happened in actual running conditions:

I was chief in a plant, the main engine being a cross-compound, condensing, double eccentric Corliss, with rocker arms on steam valves direct connected to reach rod; reach rod could not be unhooked, and there was no bypass from main steam pipe to receiver.

In shutting down one day on a hurry call the assistant overlooked putting the pin under the governor, and to make it worse, the engine stopped with the high-pressure side on the center and valves unhooked. What would you do to start?

The second instance was also with a cross-compound Corliss engine in a large manufacturing plant, having in connection with it a large foundry. The blower for this foundry was belted direct to the main line shaft. Now, as anyone knows who has ever been around a foundry, if anything happens to stop the blower while the heat is being taken off it results in dropping the bottom of the cupola and even then it will sometimes freeze up in spite of all they can do to prevent it.

One day when the heat was about half off, I heard the blower slow down and, rushing to the engine room, found that the engineer had neglected the oil cup on the high-pressure crank; the pin had run hot, and the boxes being babbitted, had melted out. No extra boxes were at hand, and 5 minutes was the limit the blower could be stopped. The engine was started and the heat saved. How would you have done it? To the old timers who have been there, these questions may be simple, but to the younger members, when they get up against something similar, the answers will be interesting. A. H. Strong.

## SHORT CIRCUITS FROM AN ENGLISH PLANT

WHAT was it the hack saw?
Why did the slide rest?
When did the governor ball,
What did the fly wheel?

"One good turn deserves another," said the flywheel as it pushed the piston through the second half of the Otto cycle. R. H.

## STARTING THAT CORLISS ENGINE

SINCE the discussion under the above title started in Practical Engineer I have noticed with much interest the different opinions of the writers, some of whom by their opinions express themselves plainly to an operating engineer that they are not in the profession. The article in the September issue is one of these self-explanatory articles. It is evident that the writer has an idea of the Corliss valve gear, but when he states that with the governor of a single eccentric engine in the starting position the valve is released and closed by the dashpot he is making a misleading statement and one which I know has some of the young fellows who are trying to master the Corliss valve puzzled. As a matter of fact the governor is in a position where cutoff does not occur as it is down on the pin or some similar attachment, and the valve is opened and closed, when starting, by the bell crank, the same as in a 4-valve non-releasing valve gear and cutoff does not occur until the governor has raised off the pin and moved the knockoff cams over until they trip the valve. He also gives directions for dropping on hook rod while engine is in motion, which is a procedure which is condemned by careful and intelligent engineers.

With a double eccentric engine, the valve is released with the governor in the starting position, but the cutoff is carried out to a point just previous to the opening of the exhaust valve on the same end, and approaches ¾ stroke. As the governor speed increases it raises and moves the knockoff cam over until the cutoff that the load demands occurs.

The original question is without a doubt a catch question, given to determine whether the man being examined is a practical engineer or not, and if he is, he would have no trouble in answering the question so as to demonstrate his practicability.

C. H. Reynolds.

## MICK WANTED VITALIZED STEAM

IN A certain plant in Providence a chief engaged a new fireman who was of a fresh catch imported direct from Ireland. One day after he had worked about a week Mick had the steam down to about 10 lb. and when the chief hurried into the fireroom there was the Mick working like the "Old Man himself."

"I say, Mick, this sort of thing won't do for me. You'll have to keep up steam better than that or get to H— out of it."

Mick looked at the chief for a few seconds with the sweat steadily tracing gullies down his dusty face, then he burst out, "Well, I done my best, but I want some fresh water."

"What's the matter with the water; it's all right."

"Well," said Mick, "you see its been in there so long and b'iled and b'iled and b'iled till there ain't no strength left in it and you can't make steam out of it nohow." R. H.

## LIGHT OR HEAVY SHOVEL FOR FIRING

IN a recent issue of Practical Engineer, there was an article by Mr. Kelley relating to the tools used in the fire-room. Now, while some of the points were very nicely covered, there was one statement that I wish to criticise.

Mr. Kelley says: "Four shovels of coal weighing 25 lb. each can be placed in the fire with less fatigue than 8 shovels weighing 12 lb. each." Now I would like to ask if a man can throw 25 lb. of coal into his fire and place it where it will do the most good?

It is my opinion, gained by actual shovel handle experience, that one can place his coal to a better advantage by using a smaller shovel. Some day when Mr. Kelley is feeling very energetic, let him bring down to the boiler house his shovel that will hold 25 lb. and I will take my little old shovel that holds 10 lb., and wager my shovel against his that I can make more steam, per pound of coal than he can.

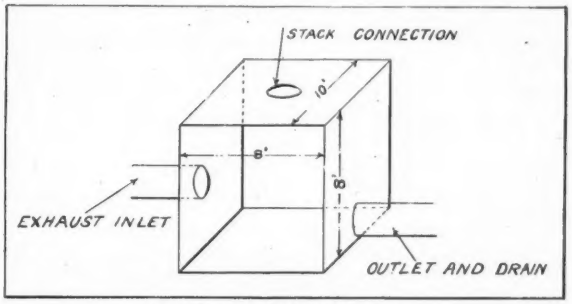
R. M. Packingham.

## EXHAUST MUFFLING

SOME time ago we installed a 360-hp. gas engine, and as exhaust was very annoying, we had to build a muffler, which we did in the following manner:

We dug a pit 8 by 8 by 10 ft. and walled it up and arched over with concrete about 18 in. thick, reinforced with scrap pipe, etc.

We ran exhaust pipes into this and left 12-in drain near bottom, also 2 ft. hole in top for manhole or stack. We discharge all cooling water into exhaust lines, these being under floor and no danger of back-




EXHAUST MUFFLING PIT

ing up into engines. It seems that the ideal muffler is one that will thoroughly expand and cool exhaust gas before it reaches the atmosphere.

We are at present exhausting 1 360, 2 125 and 1 175-hp. engines into this muffler with practically no back pressure on engines and giving perfect satisfaction.

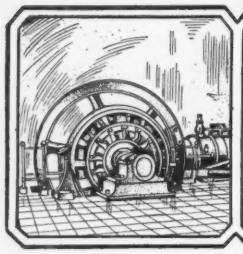
If manhole is left open on top the exhaust will set up a vibration in the air that will shake windows, etc., but by keeping this closed or by putting on a stack there will be no trouble.

We will soon install a 1000-hp. gas engine and use the same principle. E. B. J.

## SPACING BRUSH HOLDERS

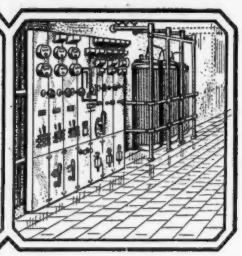
HAVING had trouble to equalize the space between brush-holders on dynamos the writer uses the following scheme. I take a piece of paper several inches wide and make it the same length as the circumference of the commutator and measure and mark this paper in equal spaces the number being the number of brush holders. Then by placing the paper around the commutator under the brushes and shifting the brush arms so that the toe or heel of each set of brushes will come to its respective mark on the paper, the brushes are equally spaced. This can be done in a few minutes time and the paper laid away for future checking up of the adjustments if the diameter of the commutator has not been altered by turning down.

Another way to check up this adjustment is to prick punch the ends of the commutator bass under one edge of each set of brushes after they have been correctly spaced. To check bring the punch mark to one set of brushes and then see that all the other brushes coincide with the punch marks on the ends of the commutator bars. C. E. N.



# Electrical Machinery

## For Generating, Transmitting and Using Current



# REVIVING A DEAD DYNAMO

By V. E. Johnson

RECENTLY there appeared in Practical Engineer an article on "Reviving a Dead Dynamo." The writer, Mr. Cultra, treats of but one cause of this trouble, and as from experience I know of several others, I recount them here as briefly as possible, hoping they may be of some benefit.

Apropos the article in question, Mr. Cultra wonders if the helper did not cause the trouble by leaving a field switch open for some time before shutting down. He also states specifically, and in some detail, that incorrect brush position was the reason for the failure to build up. Therefore, unless breaking the field also shifted the brushes, the helper was in no way responsible.

It is true that a machine running without field excitation may lose its residual magnetism through jarring, but in this case this was not the cause.

When machines operate in parallel, particularly shunt machines, weakening one of the fields may cause it to unbuild and lose its residual. Weakening the field of one machine causes the other machine to send current through the armature and run it as a motor. Further weakening increases this current until a point may be reached where the armature flux overcomes the field, unbuilding it, and causing a short circuit;

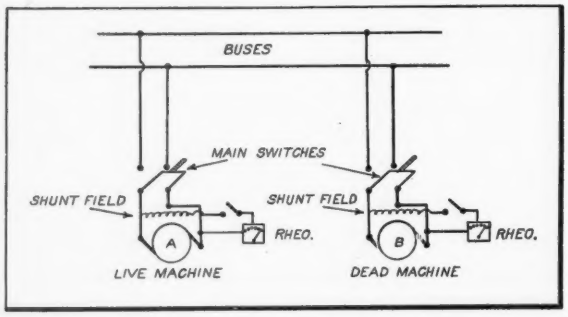



FIG. 1. RESTORING FIELD TO DYNAMO RUN IN PARALLEL

this short, of course, being due to the fact that the generator, at the time running as a motor, has no counter e. m. f.

A dynamo running alone may also unbuild in an analogous manner by being subjected to a severe overload. In a similar manner a generator thrown on the buses with a low voltage or without any field at all may, on account of the surge of armature current before the breakers operate, lose its residual.

When a dynamo is found to be "dead" from lack of residual and not from a fault or open circuit in the connections, several means may be used to revive it. If the machine operates in parallel with other machines which are generating, the simplest way is to lift all brushes off the commutator, thus cutting the armature and series field out of circuit, and closing the field switch and the main switch. This will allow current to flow through the field of the dead machine and remagnetize it. It makes no difference whether the dead machine is running or standing still, but if it is running greater care must be taken to prevent brushes from

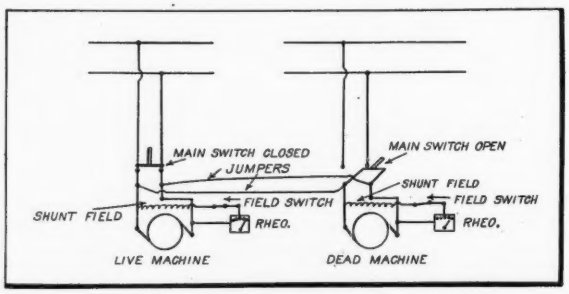



FIG. 2. USE OF JUMPERS TO RESTORE FIELD

touching the commutator through the jarring, for if 2 brushes of opposite polarity should touch at the same time, a heavy current would flow through the armature and series field. Figure 1 shows connections for this method of magnetizing, the series field being omitted. Upon closing main switch current flows from A through B's field.

If the machine is not operating in parallel with other machines, but other machines of equal or lower potential are generating current, 2 methods are available.

If the dead machine has a single blade field switch, or if it has no field switch at all, as is often the case with exciters, jumpers can be hooked between the main switch of the live machine and that of the dead machine, care being taken to see that the jumpers are connected to the machine side of the dead machine's switch and not to the load side. The brushes must be removed as before. Figure 2 shows this method of magnetizing.

The trouble with this way is that it is practically impossible to tell which way the generator will build up. To determine this replace a few brushes and note if voltmeters read forward when the machine is started up. Of course, the jumpers must be removed before replacing the brushes.

A third method eliminates this uncertainty and is conveniently applicable to machines having a 2-blade field switch connected as in Fig. 3, the usual way. The brushes need not be removed, lines being merely run from the live buses or switch to the half of the field switch to which the field is attached. If the machine is running it can be seen by the voltmeters at

once whether machine is generating in the right direction or not. If it is not, reversing the leads will remedy this. When the machine generates correctly under the influence of this separately excited field, remove the jumpers and close switch, noting if the voltage rises. Never close the field switch with jumper leads connected as a short circuit will result through the armature of the dead machine.

A word of caution in regard to breaking the field current may not come amiss. Do not try to break a strong field current suddenly as the inductive discharge causes a high voltage which may puncture the

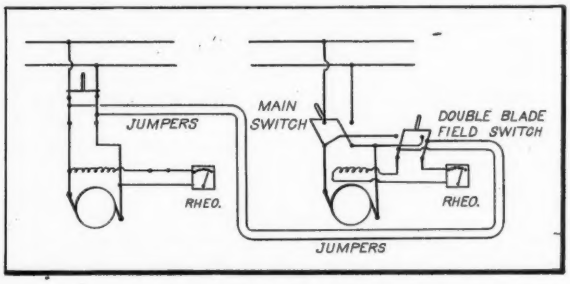



FIG. 3. JUMPER CONNECTIONS WITH DOUBLE BLADE FIELD SWITCH

field insulation. Always turn the resistance of the rheostat all in, and break connection slowly, allowing the current to burn itself out between the points.

If the machine fails to generate because of an open in the connections somewhere, the obvious remedy is to trace the connections and repair the break. I have found that three-fourths of the opens in field circuits occur in the rheostats. Whether a machine is dead because of destroyed magnetism or because of an open circuit can generally be told by looking at the voltmeter. The residual alone is generally sufficient to cause a slight deflection. If, therefore, upon plugging in the voltmeter the needle deflects slightly the cause is not lack of residual, but must be looked for elsewhere.

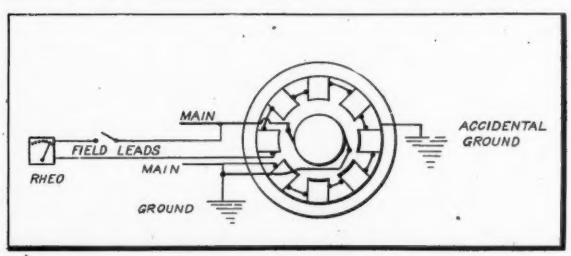



FIG. 4. LOCATION OF GROUND IN SHUNT FIELD

About 3 months ago we installed a new exciter, 120 volts, 1200 amp., turbine driven. It would not build up, its field magnetism was not destroyed, and there was no open in the field circuit. Closing the field switch caused the voltmeter to indicate 1 to 2 volts more than the residual voltage, and that was as far as it would go. So I ran lines from another exciter and separately excited the fields. I found that when I had 90 volts drop across the fields, as indicated by a voltmeter temporarily connected, I had only 50 volts across the armature. This suggested a reversed shunt coil, and upon testing with a compass this was found to be the cause. The spool was reversed and upon starting up, the machine generated.

Another time a 240-volt generator suddenly refused to generate more than about 10 volts. Separately exciting the fields at normal field current, would give about ⅓ normal voltage. I measured the resistance of one field coil by the drop of potential method and then tested the resistance across the whole field. There were 8 poles but the total resistance was only 4 times that of one pole. Upon investigation I found a ground between the field and yoke. As one side of armature circuit was grounded, this cut out ½ of the shunt coils as indicated in Fig. 4. A collar of mica was put on the pole iron between coils and yoke and the difficulty was over.

In installing a new machine, if it refuses to build up, cross the field leads, either at the field coils or where the leads join the mains. A machine for a given direction of rotation will build up with fields connected one certain way, regardless of residual polarity. If the shunt is connected reversed, the generator will not build up unless either the direction of rotation is changed or the field connections crossed, because otherwise the induced current opposes instead of helping the residual.

# RECENT DEVELOPMENTS IN THE MANUFACTURE OF INCANDESCENT ELECTRIC LAMPS*

By J. E. Randall

BY COMMON usage the name incandescent electric lamp has been limited to a lamp whose light source is the glow of a wire heated in vacuum by electric current. Incandescent electric lamps may be divided into 2 classes, depending upon whether their light-giving elements, that is their filaments, are made of carbon or of metal. At present the best examples of each class stand rather far apart both in appearance and in other features, although both are designed for the same service. One may be replaced by the other for nearly every use.

Lamps with carbon filaments have been supplied without any change in appearance for over 11 yr. Within that period one notable improvement was introduced, namely, the metalized filament. Among the lamps with metal filaments, there has been, within the last 5 yr., a procession of developments, beginning with the osmium filament, the tantalum wire filament, the pressed tungsten filament, and ending with the drawn wire tungsten filament.

## Carbon Filament Lamps

CHANGES in quality of the regular carbon filament lamps are shown in comparison with the average of 1902:

| Year | 1902 | 1904 | 1906 | 1907 | 1908 | 1909 | 1910 |
|---|---|---|---|---|---|---|---|
| Per cent of 1902 | 100 | 98.4 | 96.9 | 96.9 | 100 | 103.1 | 107.8 |

A sag in quality is indicated from 1904 to 1907, accounted for by the larger proportion of wattages below 50 and above 100 that were produced during those years. The large and small wattage lamps are known to be inferior to those between 50 and 100 watts. No changes have been made in the processes of manufacture. The best lamps of 10 yr. ago were as good as the best of the present year. The average has arisen due to the elimination of defectives.

The metalized carbon filament lamps, which are known as Gems, have made the advances shown by the following record— Calling the product of 1907 equal to 100; that of 1908 is 121; that of 1909 is 130; that of

*Abstract of a paper read at the fifth annual convention of the Illuminating Engineering Society, Chicago, September 25, 26, 27 and 28, 1911.

the past year is 133. The Gem lamp shows a sufficient superiority in quality over the regular carbon filament lamp to justify its more extensive use.

### Metal Filament Lamps

THE osmium lamp marks the beginning of development of metal filament lamps. Its great fragility and the difficulties met in fashioning the filament would, no doubt, have been eliminated had its development not been arrested by the limited supply of osmium and by the advent of the tungsten filament.

The tantalum was handicapped neither by fragility nor meager supply of metal. It is worthy of mention as an example of an article upon whose production years of research have been spent, upon whose design lavish experiments had been made. When first offered to the public, its design was finished and its qualities were thoroughly known. The mechanical weakening of the tantalum wire, due to offsetting when kept on alternating current has prevented the general introduction of the tantalum lamp in this country.

This lamp, however, was the first production of a real drawn wire lamp and its development required a construction of the filament supporting element different from any that had been used heretofore. The design of support employed in the tantalum lamp has been followed, with slight modifications, in the drawn wire tungsten filament lamp.

The tungsten filament lamp was the immediate successor of the osmium lamp. The superiority of the metal tungsten for a lamp filament was immediately recognized because of its extremely high melting point and because its melting point is not greatly below its boiling point. The brittleness of the pressed filament, especially when it is cool, has been a serious drawback to the general use of the lamp. The attachment of the filament rigidly to the circuit connections and to the intermediate connections between the filaments has probably been the chief cause for filament breakage in these lamps. The arced joint, while it was perfect electrically and mechanically, held the filament ends rigidly. Any jar to the lamp tended to make the filament vibrate and usually to break close to the joint.

The pressed tungsten filament is not ductile when cold, no matter by what process it may have been produced. It was natural, therefore, that immediate effort should be made to develop a quality of tungsten sufficiently ductile to be wrought into the form of wire. There was nothing to prevent success in this endeavor except lack of knowledge. It had been demonstrated that tantalum, which had been known as an extremely brittle metal, could be so improved in purity that it would be ductile. This knowledge would naturally lead to the belief that many of the metals which had been considered as non-ductile could, if properly prepared, be made into ductile form. In 1910 it had been proven beyond doubt that ductile tungsten could be produced; in 1911 ductile tungsten was produced on an extensive commercial scale.

It is generally believed that the presence of carbon in tungsten is the cause of its brittleness. One well known process for making pressed tungsten filaments does not involve the use of carbon, yet filaments produced by this process are as brittle as are filaments made by the use of carbon. As a matter of fact, the best pressed tungsten filaments have been those made by processes involving the use of carbon, yet they contain an amount of carbon so small that it can only be detected by the most delicate tests. For instance, filaments which are known to contain less than 0.005 per cent carbon are no more ductile than those which are found to contain 0.1 per cent. The elimination of carbon tended to reduce the length shrinkage of filaments when lamps were burned. You will doubtless recall that filaments produced in 1908 and 1909 sagged excessively and that the filaments often short-circuited due to this sag. The slack producing this sag was necessary because of the filament shrinkage.

It was evident, therefore, that to make the tungsten filament lamp a universal lamp, it would be necessary to have the filament in the form of a wire which was sufficiently ductile to be wound, when cold, upon a spider structure. The drawn tungsten wire has met this need. While the wire before being placed in the lamp is amply ductile for the purpose of winding upon the spider and for all other manipulations needed in making the lamp, it loses much of this ductility when current is passed through it in a vacuum. The method of supporting the wire on the spider and of attaching it to the circuit terminals are, therefore, important factors in the hardiness of the lamp.

The wire may be considered to consist of pure tungsten. Chemical analysis does not find other elements. The ratio of resistance hot to resistance cold is as high as can be found in any other form of the metal. The specific gravity is higher than that found for the pressed filament. Tests indicate that the wire is less brittle at every stage in the life of a lamp than are pressed filaments. There is no offsetting, either of direct or alternating current. The surface is the same in appearance, after the lamp has been burned, as that of a pressed filament. While the wire, before being placed into the lamp, may be ranked with the toughest steel in tensile strength, ductility and elasticity, the decay of these properties after it is in the lamp makes it necessary to handle these lamps with reasonable care in order to prevent breakage. Breakage in transportation and handling compares with that for carbon filament lamps.

Another feature in which the drawn wire is superior is the wide range of sizes suitable for use. A piece of wire may be drawn to a size suitable for a 6.6 amp. series burning lamp or it may be drawn to a size suitable for a 20-watt, 110-volt multiple lamp. It will, when drawn to the proper diameter, be equally satisfactory for the largest or the smallest lamp. In addition, the wire may be shaped into helices, spirals or zig-zags; thereby concentrating the light-giving element into a small volume. The latest automobile lamp is an example.

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### AN ABSORBING WATER CURE

IT WAS in a fair sized central station where the river played an important part in helping the boilers pull the load, but like all rivers, it failed sometimes when it was most needed.

M-m-m-m—sang the generators; the load indicator in the boiler room showed 4500 kw. and the red light beside it winked industriously to give warning of a further increase soon to come.

Suddenly into the engine room bursts the water tender, demanding:

"Are all the United Engineers having a joint dance, or where are you gettin' all that load?"

"River's gone to the devil—putting on 'nother 'turb,' " responded the oiler, indifferently.

"Well, what the blazes got the river?" asked the water tender.

"The fish drank it up, yer darn fool," and with that the water tender returned to his own domain telling the fireman to put in another boiler, and on the side remarking what he thought of oilers in general.

# RESISTANCE COILS AND WATER RHEOSTATS

## SIZE OF WIRE NEEDED TO CARRY A GIVEN CURRENT AND LENGTH NEEDED FOR A GIVEN RESISTANCE

FREQUENTLY it becomes desirable for either permanent or temporary use to construct a rheostat for cutting down the electromotive force applied to a piece of apparatus or for absorbing energy during a test. For the former purpose some kind of a drum resistance is most convenient, made up of wire wound upon a cylinder and arranged with a movable contact. Where it is desired to absorb the energy for a test, the second form is generally more available, consisting either of coils of wire hanging loose in the air so as to get the greatest cooling effect, or of some form of liquid rheostat, or of a wire rheostat immersed in liquid for the sake of the cooling effect.

### Drum Resistance Coils

IT is evident that the amount of current that can be taken care of by a drum resistance depends upon the heat energy that can be radiated, inasmuch as the temperature of the wire must not rise above a certain degree. The radiating surface is the surface of the cylinder and is found by multiplying 3.1416 by the diameter of the drum in inches and by its length in inches.

The rise in temperature for a watt dissipated from each square inch of cylinder surface depends on the diameter of the drum, material of which it is made, and the circulation of air around it. For one case of a cast-iron cylinder 6½ in. diameter by 56 in. length, it was found that the rise in temperature was 90 deg. for each watt radiated per square inch of drum surface. For an uninsulated wire, the allowable safe rise is usually given as 200 deg. F., so that, if a rise of 180 deg., which would be that due to the radiation of 2 watts per square inch of drum surface be allowed, it will in most cases be within the safe limit.

The energy transformed into heat in a resistance coil can be found either by multiplying the square of the current by the resistance of the coil or by dividing the square of the electromotive force applied at the ends by the resistance of the coil. The resistance of the wire increases as the length and decreases as the square of the diameter, and may be found by multiplying some constant by the length of the wire in inches and dividing this product by the square of the diameter. The constant in this case will be the ohms resistance of a wire 0.001 in. diameter and 1 in. in length, the diameter of a wire being always measured, for electrical computation, in thousandths of an inch or "mils."

To get the length of wire on any coil we have to know the diameter of the drum and the number of turns of wire on it. The length of one turn will be 3.1416 times the diameter of the drum, and the total length of wire will be this circumference times the number of turns wound on; the number of turns will be the length in inches of the winding surface divided by the pitch of the winding, that is, the distance from the center of one wire to the center of that lying next to it, and for ordinary close winding is equal to 0.00123 times the diameter of the wire in mils.

Combining these facts into a single expression, we find that the resistance of the wire on any drum is equal to a constant, times 3.1416 times the diameter of the drum in inches, times the length in inches, divided by 0.00123 times the cube of the diameter of the wire expressed in thousandths of an inch, or mils.

To get the watts energy turned into heat, we either multiply the square of the current in the coil by this resistance or divide the square of the voltage by the resistance; and the watts per square inch will be found by dividing the total number of watts turned into heat by the surface of the drum in square inches. If this is less than 2, the coil will work safely.

### Designing the Coil

AS a rule the values known are, the voltage which must be taken up by the coil, the current which it must carry and the temperature rise allowable. In that case we find the total energy to be dissipated by multiplying the current in amperes by the electromotive force in volts, giving the total watts used up in the resistance coil. This amount multiplied by the rise in temperature for one watt dissipated per square inch and which we have seen is 90 deg. for one case, and divided by 3.1416 times the allowable temperature rise, will give us the figure which must be made equal to the diameter of the drum times its length in inches.

Having found the diameter and length of the drum required to dissipate the heat, the diameter of the wire of any given material is found as follows: Multiply the diameter of the drum in inches by its length in inches and divide by the resistance which the coil is to have. Multiply this quotient by the constant, which we will call K, for the material to be used, and extract the cube root of this product; multiply the root by 13.68 and the product will be the diameter of the wire expressed in thousandths of an inch or mils.

### Example Solved

TO solve a problem, assume that we wish a rheostat to carry 5 amperes of current safely and to use up 25 volts of electromotive force; assume that we shall have 90 deg. rise in temperature for each watt radiated per square inch of drum surface and that the allowable rise in temperature is 200 deg. F.

The watts to be dissipated will be the current times the electromotive force or $25 \times 5 = 125$ watts. The resistance of the coil will be $25 \div 5$ or 5 ohms. Following our rule, we multiply 125 watts by 90, and divide this product by the product of $3.1416 \times 200$. This gives us 17.9 which is to be made equal to the product of the diameter of the drum in inches times its length in inches. We can assume either one of these and find the other. If we make the diameter 1 in. it gives a length of 17.9 in., or say 18 in., which is a reasonable proportion. We might, of course, make the diameter 2 in. and the length 9 in. if we so chose.

To determine the diameter of the wire, assume that it is to be of iron, and from the list of values we find that the constant, K, is 6.9. From the rule already given we then have $1 \times 18 \times 6.9 \div 5 = 24.85$, and extracting the cube root of this we get 2.92. This is to be multiplied by the constant 13.68, which gives as the product 39.95, the diameter of the wire in mils. From a wire table, as given in a previous issue in the rules and data sheet, we find that this calls for No. 18 iron wire for the coil.

### Values of K

IN order to make this process applicable to any material, L. W. Rosenthal gives in the Electrical World the following values of the constant, K: For aluminum, 2; copper, 1.2; brass, 4; iron, 6.9; galvanized iron E. B. B. brand, 5.3, B. B. brand 6.3, steel 7.4; ferro-nickel, 14.2; German silver, 18 per cent nickel, 15.8, 30 per cent nickel, 32.1; Advance resistance wire, 25; Climax resistance wire, 46.4.

### Weight of Wire Needed

TO get the total weight of wire needed, multiply the temperature rise for 1 watt per square inch radiation by the watts to be dissipated, and divide by the allowable temperature rise; extract the cube root of the quotient, multiply by the constant K and by 8030; the product will be the weight in pounds required.

### Liquid Rheostats

FOR rheostats which are entirely of liquid, generally water, or of wire immersed in liquid, it is essential that there should be sufficient surface to carry off the heat generated, and usually this is largely dissipated by evaporation of the liquid from the surface rather than by radiation.

In furnishing load for large units it is, however, necessary to have the liquid cooled by means of cooling coils or circulated, the ideal condition being a wire rheostat submerged in a flowing stream. Plates submerged in quiet fresh water do not work well, but when they can be suspended in still salt water from a dock an all liquid rheostatic load can be used to good advantage.

### Data for Submerged Rheostat

FOR a wire coil submerged rheostat, P. M. Brown gives in the Electrical World the following data:

To get the diameter of the wire in mils, square the current to be carried, extract the cube root and multiply by a constant which if the container is a tank or barrel is from 3.25 to 2.75, and if a river of moderate flow, is 2.75 to 2.25; for rapid flow with low temperature, 2.25 to 2. The lower value of the constant is used where the cooling of the wire will be more rapid. If barrels are used as containers, not over 5 kilowatts should be dissipated in each barrel.

The length of wire needed in feet is to be found by multiplying the electromotive force to be applied at the ends of the rheostat by the square of the diameter of the wire in mils, and dividing this by the product of current times 112, the 112 being the resistance of a wire a thousandth of an inch in diameter and 1 ft. long.

### An Actual Case

IT was necessary to have a 3-phase generator of 2500 kw. capacity, at 2400 volts electromotive force. This gave 603 amperes per phase when connected in delta, or 301.5 amperes per rheostat coil with 1385 volts across a coil when connected in star to a neutral center. The constant was taken at 2.45 as the rheostat was to be immersed in the river. From the rule already given we square 301.5, extract the cube root and multiply by 2.45, which gives as the diameter 110 mils, which would be about No. 12 British wire gage, 109 mils, or a No. 9 Brown & Sharp gage, 114 mils.

Using the British wire gage which is nearer the requirements, we have, in order to get the length from the rule already given, 1385 times the square of 109, and this product divided by 112×301.5, giving 488 ft. as the needed length. Coils were wound on 1½-in. iron pipe and then slipped off, 112 turns being put in a coil, giving a length of 61 ft. per coil, so that 8 coils were needed for each rheostat. These were attached to porcelain knobs and mounted on wooden frames, the coils being kept 12 in. apart, and one inch from the wood frame, with 6 in. between the coils on a frame.

For a smaller submerged rheostat, American Electrican gives that for 100 amperes a 40-gal. barrel should be used unless the water is in circulation. For the different sizes of wire and voltages, the safe amperes and lengths needed will be as given in the Rules and Tables sheet. Tops of the coils should be kept at least 3 in. below the water surface; water should be circulated so that the temperature is kept below 200 deg.; and a partition arranged in the barrel or tank so that the water flows from top to bottom on one side of the partition, and from bottom to top on the other side, and then passes out the overflow.

### Water Rheostats

SOME data given by Messrs. Willis and Merrill, in the American Electrician, are of value in this connection. In a test of a railway generating station, plates 1 ft. by 5 ft., and ¼ in. thick, spaced 6 in. apart, were used, lowered into the salt water from the dock. When submerged 2 ft., giving 2 sq. ft. of surface, the rheostat took care of 800 amperes at 800 volts, or 400 amperes per sq. ft. At 550 volts, 4.5 sq. ft. of surface took care of 1450 amperes, or 322 amperes per sq. ft.

In using a tank 4 ft. by 4 ft. by 5 ft., it was found to take care of 1000 amperes at 550 volts, when a stream from the hose was used to cool the water. With a 3 ft. depth of immersion, it gave 36 sq. ft. of surface on both sides of both plates, or 280 amperes per sq. ft., the distance between plates being 5 to 6 in.

For making a barrel rheostat, Willis recommends a 60-gal. barrel for 50 kw. load, and the use of galvanized iron formed into concentric cylinders with space of 3 in. between, and for close regulation trimmed down to a point at the bottom. For such a barrel a tablespoonful only of salt should be used, or, if less than 50 amperes is to be carried no salt at all need be used with ordinary city water.

### Substances to Reduce Resistance

VARIOUS substances may be used in the water, each having its advantages and disadvantages. Salt when used gives off chlorine which attacks the electrodes and also any metal in the room if the fumes are allowed to become dense. If sulphuric acid is used, it necessitates the use of a wooden vessel and nails in this may be eaten away; also spray from the surface will attack metal. If more than 30 per cent acid is used it causes the resistance in the rheostat to increase instead of diminish. Sulphate of copper or blue vitrol will do for a few cases, but the solution will attack iron almost as readily as will the sulphuric acid; also, the solution has a rather high resistance. Caustic soda or caustic potash may be used and are excellent. They attack copper and iron but slightly, and a strong solution has a very low resistance. Lead is, however, readily attacked by these solutions, hence they should be kept away from solder. Washing soda will give almost equally as good results, though it may attack a copper electrode.

As a rule, 3 sq. in. of electrode per ampere current should be allowed, only one side of the electrode being counted, unless the positive electrode is between 2 negative plates. In emergency 5 to 10 amperes per sq. in. may be used if steadiness of current is not re-

quired. It is better to use a shallow tank so as to get a large evaporating surface, and broad shallow electrodes set well down towards the bottom. The tank should be well insulated from the ground with glass or porcelain insulators.

Resistance of pure water from the tap is found to be about 100 ohms per cubic foot, and so long as the temperature is kept below the boiling point, the current density or time of flow effects the resistance but little. The resistance of the rheostat can be varied either by varying the immersion of the electrodes or by varying the distance between them, but in no case should the distance be less than 3 in. in order to avoid short circuit.

Resistance may also be varied by varying the strength of the acid or salt solution, the variation of resistance with strength being as shown on the curves in the data sheet. As an actual case, suppose that it be required to carry 50 amperes at 110 volts in a rheostat using salt water. Allowing 3 sq. in. per ampere, we should have $50 \times 3 = 150$ sq. in. of surface required on the electrode, or a plate, say, 10 by 15 in. In order to give 50 amperes at 110 volts, the resistance should be $110 \div 50 = 2.2$ ohms, and if we allow a salt solution of 1 per cent we shall find from the curves that the resistance per cubic foot for this strength is 2.1 ohms. This would require then $2.2 \div 2.1 = 1.05$ cu. ft. of water between the plates. As the area of one plate is 150 sq. in., or 1.04 sq. ft., the distance between plates will be 1.05 divided by 1.04, or 1.01 ft. The requirements would be sufficiently met by putting the plates at 12 in. apart.

# AMMONIA PROBLEMS

## QUESTIONS ON PURGING AND CONDENSER PRESSURES ANSWERED

By F. E. Matthews

IN A 35-ton ice plant in an Ohio city, the question arose—how to get air out of the system by the means provided, without losing a large amount of ammonia gas? From the sketch it will be seen that the discharge gas from the compressor goes through a 4-in. cross valve, out the discharge pipe, and through the oil separating trap, and then into a 4-in. gas header that has 7 outlets through 7 1¼-in. angle valves into the 7 stands of condenser pipes.

The air trap (which is a horizontal piece of 3-in. pipe about 4 ft. long) is clamped to the gas header parallel with it, and has a ½-in. pipe leading from the other end of it for discharging the air.

According to one argument, in order to get rid of air, there must be a good flow of water on the condensers and the ammonia be pumped to a high pressure and condensed. The air will then collect on the top of the liquid in the condensers, and not being condensed, can be blown off. But in this plant the air discharge being connected with the gas header, all of these 1¼-in. angle valves must be left open in order to connect the condensers with the air trap, and this

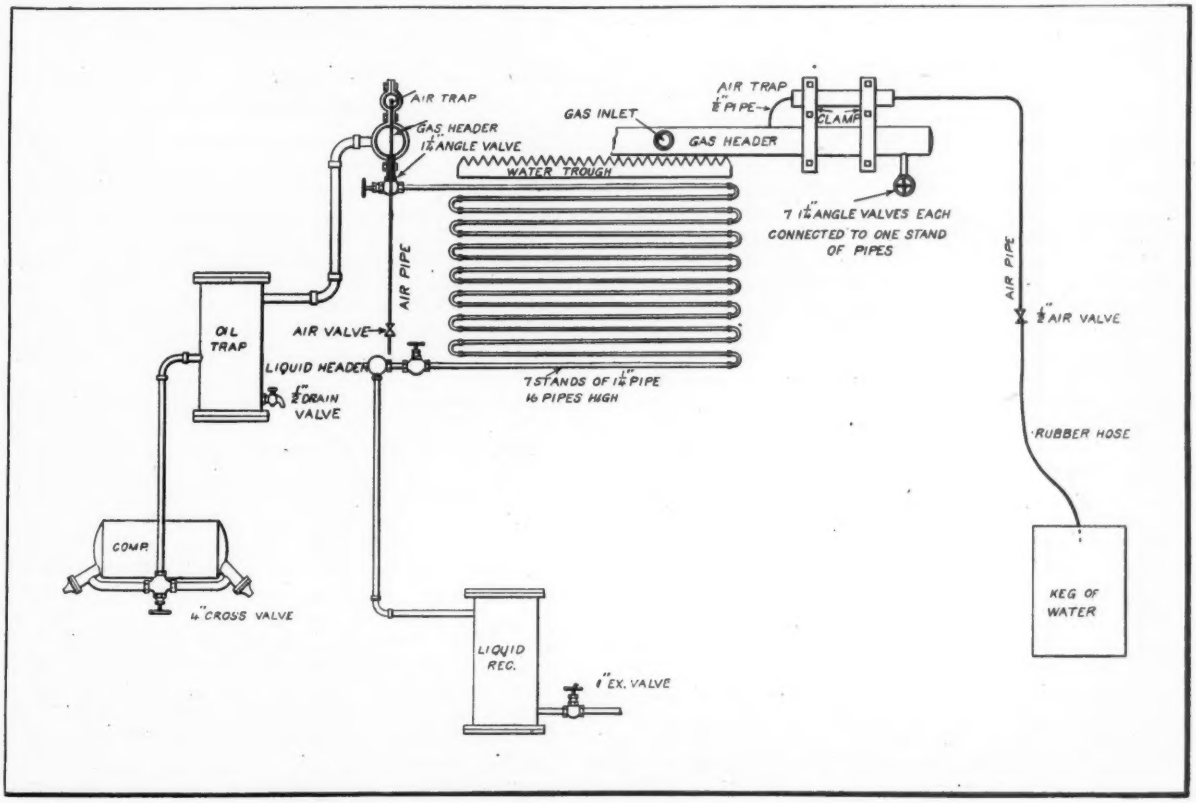


DIAGRAM OF ARRANGEMENT FOR REMOVING AIR FROM A 35-TON ICE PLANT

leaves an opening on the discharge line all the way down to the cross valve on the compressor. Now must all this gas be lost?

### Purging of Air

MANY systems do not have the "air" or foreign gas traps, in which case it is advantageous either to shut off a part of the condensers to prevent the incoming of hot gas which would not allow the slightly lighter foreign gases to separate out, (due to difference in specific gravity) from the ammonia; or in case of small machines having only a few stands of condensers, to shut the compressor down. In either case water should be allowed to continue flowing over the condenser to aid the separation of the ammonia from the permanent gases by liquifying it, which obviously greatly increases the difference in specific gravity between the substance to be saved and that to be purged out.

When there is no further drop in head pressure, indicating that all of the ammonia that can be made to change into the liquid state at the temperature of the cooling water supplied, has been liquified, the valves connecting the highest part of the condenser to the purge line may be slightly opened and the gas conducted into a pail or tank of water. This may be most conveniently accomplished by means of a small short rubber hose, the end of which is submerged in the water.

The relief of pressure incident to opening the purge valve immediately causes the liquid ammonia lying in the bottom of the condenser to boil and evolve ammonia vapors which passing upward through the condenser, pipe after pipe, drive the unliquefiable foreign gases before them. There will, of course, always be some slight intermingling of the 2 gases, but this is reduced to a minimum by the above method.

Too much emphasis cannot be put upon the importance of, first, liquefying as much as possible of the ammonia to get it out of the mechanical mixture of ammonia and foreign gases, and, second, allowing liberal time for the gases in question, which are at most not widely different in specific gravity, to separate due to that slight difference in specific gravity. These details having been observed, little ammonia will pass off with the purged gases as the surface exposed by one gas to the other, assuming perfect separation, which obviously is never realized, would be the cross section of the pipe; even if the foreign gases were heavier than ammonia, they would have to be considerably heavier, in fact almost as much heavier as a liquid would be, in order to run back down the condenser against an upward current of ammonia gas.

This point is raised because the question has been raised even by builders of refrigerating machines whether the above method of purging would be effective in ridding the system of gases heavier than the vapors of ammonia. It is our opinion, based on the above reasoning, that it would be.

The above describes the general method employed with the usual form of apparatus. Where there is a cylinder higher than the highest point in the condenser, for the accumulation of the permanent gases, the operation is the same except that it is to be expected that small quantities of permanent gases will find their way into this receiver and may be purged out while the plant is in operation. Even with the receiver in question it would be advisable to take the precautions as to time and temperature prescribed for the usual system.

If there is no valve by which the main hot gas header can be shut off from the purge line the gas in that line will undoubtedly expand under the reduction in pressure due to the opening of the purge valve and some of it, since the discharge line is less likely to contain permanent gases, will be lost. On the other hand the amount that this gas will expand is limited, for there is no liquid ammonia behind it to keep up the supply of gas as in the case of the condenser. As a matter of fact, the amount of permanent gas escaping from the discharge line would be very small because of the slight reduction in pressure due to the opening of the purge valve. The escape of half the gas would be necessary to halve the absolute pressure, volume remaining constant.

Of course, whatever be the system, the operator must take due precautions not to allow the escape of gases too rich in ammonia. This is accomplished by discharging the purged products into a bucket of water. The foreign gases will rise as bubbles to the top of the water, due to their low degree of solubility in water, while the ammonia will be absorbed and no bubbles will rise except in the limiting case, which must be avoided, when the water in the pail has become saturated or has absorbed all the ammonia it will hold.

In the case of pure ammonia gas discharged into water, not only will there be no bubbles arise, but the fact is further apparent from the sharp crackling sound produced by the collision of the walls of water surrounding the ammonia gas bubbles, when the gas is absorbed. The sound in question is similar to that of steam when poured into cold water, the result being due to a similar cause.

### High vs. Low Condensing Pressure

OPERATING under high pressure causes an unquestionable loss, not only in refrigeration in the refrigerating system proper, but in power in the steam engine as well. The temperature of liquid ammonia from 185-lb. gas is about 95 deg. F., while that from 150-lb. gas is only about 85 deg. If the ammonia is fed to the expansion coils in which there is a pressure of 15 lb., its temperature must first be reduced from 95 or 85 deg., as the case may be, to 0 deg. F. Now the specific heat of ammonia liquid or the amount of heat required to raise one pound one degree is about 0.5 units, or to cool one pound 90 deg. about 45 units. This amount of refrigeration must be contributed by the heat absorbed by the evaporation of the liquid, which is proportional to the latent heat of vaporization of the liquid and for ammonia at 0 deg. F., is 555 units. The refrigeration necessarily expended in cooling 95 deg. liquid is 475 ÷ 555 or 85.5 per cent of the entire refrigeration it contains.

The operating of the plant so as to employ 85 deg. instead of 95 deg. liquid ammonia will similarly reduce the amount of refrigeration required to cool the liquid down to 0 deg. F., from 8.55 per cent to 7.65 per cent, or 0.9 per cent. This 0.9 per cent of the total refrigeration lost when operating at the higher pressure is available for useful work when operating at the lower pressure.

In addition to the above saving is also that due to the higher mechanical efficiency of the ammonia compressor when operating at the lower head pressure. The lower the pressure of the compressed gas in clearance spaces between the compressor pistons and cylinder heads and around valve ports the less will be the space that it will take up in the cylinder after re-

expansion during the suction stroke of the compressor, this space not being available for incoming cold gas.

In addition to the foregoing is the absolute loss of power due to the higher mean effective pressure of both the compressor and the steam engine—which affects in direct ratio the horsepower required of the engine by the compressor.

2. About 3 yr. ago, in running a small compression refrigerating machine, it was noticed that although they had plenty of good cold well water, and a pump that would easily deliver torrents of it, and although they were not using the exhaust steam for any purpose whatever, the chief engineer would skimp the water on the condensers and keep a condensing pressure of 180 to 185 lb., when he could easily have kept it at 150 lb. or less. What did he expect to gain by this? It seems to be a loss. The plant was crowded and the compressor was driven by a 12 by 36-in. Corliss engine making 125 r. p. m.

3. Everything being in first-class order and properly handled, which is considered the more economical, the compression or the absorption system of ice making and refrigeration?

The compression and the absorption refrigerating system each has its own distinct field. The former is generally conceded to be the more economical when producing comparatively high refrigerator temperatures and the latter when producing comparatively low.

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# INSULATION OF COLD STORAGE ROOMS

## COMPARATIVE VALUE OF FILLED WALLS, AIR SPACE AND CORK BOARD

IN a paper before the Southern Ice Exchange, Edward Dunnick makes comparison of the 3 methods substantially as follows:

### Hollow Filled Walls

HOLLOW wall-filling insulation answers the purpose very well. It was usually built of wood and easy to construct, but its real value was uncertain. Its efficiency depended upon the thickness and kind of filling used, those that would resist the action of moisture giving the most satisfactory results. As soon as moisture was absorbed the insulation decreased in value, until it became water soaked, when it was worthless. The fillings used for this purpose were charcoal cinders, sawdust, mill shavings, mineral wool and rice chaff. We also had granulated cork for filling, and it was the only substance that would give anything like uniform results. As the fillings were usually encased in the wood the life of this insulation was, of course, the life of the lumber, varying from 7 to 11 years.

Whenever it is necessary to use filling I strongly recommend that the lumber be treated with some kind of wood-preserving material, in order to make it last as long as possible. In fact, it is good practice to treat thus all lumber in construction of cold storage buildings.

### Air Spaces

AIR space insulation was a decided improvement over the filling construction, because it gave more uniform results. Air spaces were usually constructed of a series of boards and paper, and the efficiency, while it depended on number of air spaces, boards and paper, first of all depended upon the care with which it was constructed. Careless workmanship would make this class of insulation almost worthless, no matter how good the material used.

No 2 jobs erected in the same manner would give the same results. We must admit, however, that some of this insulation would give excellent results; in fact, as good as the average run of the modern insulating materials. As this class of insulation is usually of wood construction it was very easily destroyed by fire. It lasted the life of the lumber, or about 7 to 11 years. Like the filling construction it required thick walls, and then they could not be made sanitary.

### Special Materials

MANUFACTURED insulating materials may be termed modern cold storage insulation. Various insulating firms in this country manufacture these materials of different substances and sell them on the market at the present time.

When you consider the requirements of a good insulating material you naturally think of some substance that transmits little heat, not affected by moisture, not affected by fire, and particularly one that is durable. Cork meets these requirements.

There are two grades of corkboard on the market—one made of all pure cork and the other a composition of cork and some cementing material.

In the manufacture of all pure corkboard the cork waste is first cut in a size to go through a ¾-in. mesh screen. This pure granulated cork is compressed in iron moulds, and baked in an oven, no foreign cementing material being used, because none is necessary. The natural gum in the cork thoroughly cements the fragments together.

The finished product is a chocolate colored sheet of cork, very light in weight and having considerable structural strength. The heating process drives off all volatile matter and moisture, and thus increases the volume of confined air. When examined under the microscope it will show numerous small air cells, hermetically sealed together and impervious to air and moisture, this cellular structure being one of the strong points in its efficiency.

In all composition board the cork is cut up in small fragments and mixed with some cementing material, usually of asphaltic nature. This mixture is then pressed into sheets, so that the voids between the fragments of cork are filled with a cement which has a high transmission of heat, thus making the efficiency of this class of corkboard much less than that of the all cork variety.

One of the prime factors of any insulating material is efficiency. Any insulation to be efficient must be kept dry and free from moisture. It must be of a nature to resist capillary attraction. Here cork scores another strong point. After the insulating material is manufactured it can be tested for the transmission of heat. Tests on corkboard made by Prof. Norton, Walter Kennedy and other promient engineers throughout the country show the transmission of 1 in. thickness pure corkboard to be approximately 6.4 B. t. u. per square foot per degree difference in temperature in 24 hr., while the transmission of composition corkboard under similar conditions is approximately 8.8.

### Fireproof Construction

IN this progressive age we find that it is necessary to construct plants of durable material, such as brick and concrete. The same is true for the insulation. For this purpose there is nothing as satisfactory and durable as corkboard erected to brick or concrete walls

in a cement mortar and the surface covered with a cement plaster. The same is true of corkboard in floors between 2 layers of concrete and also when erected to a concrete ceiling in cement mortar. These make solid and durable constructions, and occupy minimum space. One important thing in this connection which should not be overlooked is the low insurance rate on this class of insulation.

There is a growing demand for larger ice storage rooms. If they are insulated properly they require little refrigeration, and the ice can be kept in good shape at a small cost. The cost of the insulation for these rooms will vary with the quality of material used and the amount of insulation applied. The following figures will give a rough idea of the cost of corkboard insulation per ton of ice stored. The first figure in each case is the maximum amount of insulation that should be used; while the second figure is the cost of the minimum amount of insulation that can be used and get anything like satisfactory results. In rooms of 500 tons capacity the cost of the insulation will vary from $4.00 to $2.85 per ton of ice. Rooms of 1500 tons capacity from $2.85 to $2.00 per ton. Rooms of 2500 tons capacity from $2.10 to $1.60 per ton. Rooms of 7000 tons capacity from $1.40 to $1.10 per ton.

Insulation for freezing tanks is constantly receiving more careful attention. Thoroughly insulated tanks are sure to increase the capacity of your plant. All the ice machine companies have recognized this essential point and are specifying better insulation for the freezing tanks. For the floor corkboard laid on concrete is usually specified, and it is without doubt the best construction that can be used. For the sides of the tank either granulated cork or corkboard according to the conditions.

# WHAT'S BECOME OF THAT AMMONIA?

## SUGGESTIONS FROM OPERATORS AT THE MIDDLE STATES ICE PRODUCERS CONVENTION

THIS refers to losses from other causes besides leakage and opinions varied as will be seen by what follows:

J. C. Atwood stated as a positive fact that in a plant operated under normal conditions, losses due to causes other than leakage can practically be ignored. Unless the condensing pressure is very high there is little decomposition of ammonia and an excessive consumption of ammonia should not be explained by decomposition. If a plant is operated under an abnormally high pressure, due either to a scarcity or to a high temperature of the cooling water, or to insufficient condenser capacity, operating engineers often try to reduce the pressure by what is called "purging the condenser" to remove the so-called "foul gas," which they believe might be the cause for the high pressure. In doing this there will invariably be considerable loss of ammonia, and in some cases the loss will be quite heavy.

If there is actually sufficient air in a condenser to interfere with the economical operation of the plant, the air should be removed by purging the condenser. It is always best to do this while the machine is shut down, or if this is not feasible, by purging one condenser coil at a time. In both cases, the condenser should be flushed with cold water to condense as much of the ammonia as possible, thus reducing the loss of ammonia to a minimum. Many absorption plants suffer from formation of so-called "foul gases," due to decomposition of the water by electric currents. Accumulation of such foul gases should always be blown off through the absorbers, and if necessary, a special connection should be made for that purpose between the condenser and the absorber.

J. P. Reilly, expressed the opinion that there is no cause for loss of anhydrous ammonia in compression machine other than leakage. This statement is made from the commercially practical stand-point.

According to Ramsey & Young, the temperature of decomposition of anhydrous ammonia is about 900 deg. F. White & Melville state close to 850 deg. F. Suppose that there is a partial dissociation or decomposition at 450 to 500 deg. F., it is a question if in the operation of refrigerating machine there are any factors operative to bring about such conditions. Mr. Reilly does not believe that dissociation or decomposition of ammonia in a refrigerating plant has anything to do with the loss of ammonia.

He cites a severe test which should be worth something from the practical standpoint along the line of this discussion. A few years ago, because of unusual conditions, one of our ice plants was operated for nearly 3 months with a head pressure of from 250 to 265 lb. and with condensing water (from the river) varying from 75 to nearly 90 deg. F., and each day produced its full quantity of ice, over 200 tons.

Consumption of anhydrous ammonia for this plant for years averaged 8600 lb., and the consumption for the year in question was about the average—in fact the same quantity was put in to replenish during June, July and August, as in previous years. This is an old plant with 3 machines and producing can ice. If there was such a thing as dissociation or decomposition, it would seem as if this plant should have suffered thereby.

T. S. Russell said that nearly all losses of ammonia in refrigeration plants come from leakage. Ammonia will start to decompose or to disintegrate at times. All things in nature tend to assume their most stable form and everything decomposes even when the decomposition which is taking place is not noticeable and in a good many places cannot be measured. Increase of temperature as a general thing helps along the decomposition and then decomposition becomes noticeable so as to be measured.

About 3 years ago his firm had occasion to go into the question of decomposition of ammonia, not only from a chemical standpoint, but also from the operating standpoint and as a result of those experiments we found that at about 205 lb. condensing pressure and from there on up, the ammonia begins to disappear slightly and when you get up around 270 to 280 lb. condensing pressure, the decomposition is really noticeable. According to those tests any one working with a condensing pressure below 205 lb. will get the best results from an ammonia standpoint.

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RELIABILITY IN A MAN demands respect from those who are superior to him in position, those above know that he and that with which he has to do will run like a piece of the best machinery would had it the brains to forsee in time to prevent the little thing which sometimes causes it to break down or miss.

"The reliable man is sure to better himself, he is in demand everywhere, he is sought by the big men who want to know that certain things are going to be all right weeks and months ahead, because so and so, the reliable man, is on the job to look after their interests."

# EUROPEAN POWER PLANT PRACTICE

## LATEST DEVELOPMENT FROM ALL COUNTRIES; TAR AS FUEL FOR DIESEL ENGINES

By Francis G. Wickware

RESULTS of 2 independent investigations, by prominent German firms, of the possibilities of raw gas-works tar as a fuel for Diesel engines are reported in recent issues of the Journal fur Gasbeleuchtung und Wasserversorgung and Die Gasmotorentechnik. For several years the Maschinenfabrik Augsburg-Nurnberg has been using tar oil in Diesel engines with successful results, and since 1909 its new design of horizontal engines. In October of that year were begun experiments with a 100-hp. engine employing raw tar as fuel.

### Kinds of Tar Used

TARS of 2 qualities were investigated—first, a thin tar from an inclined gas retort, of 15,330 B.t.u per pound, and later a thick coke-oven tar obtained from Dr. Otto's experimental coking plant in Dahlhausen, with a heat value of 15,360 B.t.u. per pound. The proportion of light oil introduced into the cylinder to assist in igniting the tar was about 2 per cent of the total fuel consumption at full load. Ignition and combustion were in all cases very satisfactory, and the engine worked perfectly under a load of 124 to 130 hp.

### Some Results and Data

SINCE early in February of this year a more extended test has been made with a 100-hp. Augsburg-Nurnberg engine installed at the Otto coking plant, which has been operating continuously on coke-oven tar under wide fluctuations of load from 6 a. m. Monday to midnight on Saturday. Fouling of the piston has not yet occurred, and other interruptions which might have been anticipated from the nature of the fuel have been entirely absent. The engine is of essentially the same design as the Augsburg-Nurnberg engine equipped for operation on tar oil.

Quantity of ignition oil is not varied with load fluctuations, but remains constant at about 2 per cent of the fuel consumption at full load. This auxiliary fuel is unnecessary either for starting the engine or for heating it up to working temperature. The engine can be started on tar alone, and run on tar at all loads. Superior efficiency of combustion, however, is obtained when a small proportion of ignition oil is introduced into the cylinder.

Notwithstanding the encouraging nature of these results, the reporter warns his readers against their acceptance as conclusive proof that the problem of employing tar as a fuel for Diesel engines is completely solved.

### Korting Bros. Experiments on Gas House Tar

THE doubtful questions are partially resolved, in sofar as tar from vertical gas retorts are concerned, by the results of the tests reported in Die Gasmotorentechnik, which were undertaken by the firm of Korting Brothers at the instance of the Deutsche-Continental Gas Co., a corporation operating gas works in a number of German cities.

In this investigation, vertical-retort tar obtained from various works, operating on British, Westphalian and Silesian coals, was supplied to a 100-hp. horizontal Diesel engine direct-connected to a direct-current generator, working alongside suction gas-engine units in the power plant of the Korting works. Paraffin oil was used for initiating combustion.

Fuel supply was varied according to the load on the engine by means of a governing device acting on the 2 fuel pumps. The proportion of tar and ignition oil was also capable of regulation, and the fuel valves were so arranged that the tar pump could be changed over the paraffin-oil supply while the engine cylinder was being heated up to working temperature.

It appears from the available data of the calorific values of the tars used that the total heat consumption in operation with tar and ignition oil is probably as great as with paraffin oil alone. The consumption of ignition oil was very small, averaging 2 per cent at full load, 7.5 per cent at ¾ load, and 13 per cent at ½ load. At full load the motor could have been operated on tar alone, but for certain reasons this was not attempted.

### Fuel Consumption

ASSUMING the heat value of the ignition oil to be 18,000 B.t.u. per pound, and that of the tar to be 15,300 B.t.u per pound, the results show that an ordinary 100-hp. Diesel engine, requiring under other conditions about 3330 B.t.u per horsepower per hour, will consume tar and ignition oil in about the following proportions and quantities per horsepower per hour:

| | Tar | Paraffin oil. |
|---|---|---|
| At full load | .47 lb. | .008 lb. |
| At three-quarter load | .44 lb. | .031 lb. |
| At half load | .41 lb. | .053 lb. |

Effect of change in the nature of the fuel was investigated in a 60-hr. run of the engine, during which tars from a number of different sources were used. The engine ran throughout the test practically without smoke, and at the end the valves and nozzles were found to be entirely unobstructed. Little residue of any sort was apparent. During this test also the engine was subjected to sudden and wide variations of load, without appreciable effect on the running speed.

To the reporter, these results indicate not only an important development in Diesel-engine technology, but the opening of a new outlet for the tar production of vertical-retort gas plants. A typical vertical retort handling about 10 long tons of coal daily produces about 1100 lb. of tar, sufficient to supply a 200-hp. engine for 12 hr. at full load.

### Fuel Cost

WITH tar at $7.50 per long ton, the prevailing price in Germany, the cost per horsepower per hour would be 0.16 cent for tar and 0.008 cent for paraffin oil, at the prevailing price of $21.25 per long ton, a total of 0.168 cent. In a 100-hp. engine running 3000 hr. a year, the total annual fuel cost would be: tar, $480; ignition oil, $23.25; and ignition oil for starting, $30; a total of $533.25. The corresponding annual fuel cost with paraffin-oil operation would be $1,177.50, and with tar oil $651.75.

Changes in design necessary to fit a Diesel engine for operation on tar add only about 5 per cent to the cost. For plants within easy reach of a supply of vertical-retort tar, the installation of a Diesel engine for operation on this fuel would appear to be a very profitable investment.

# THE ACME STEAM ENGINE

WITH the rapid growth and popularity of the gas engine, the impression has become quite general that the small steam engine is no longer an important factor in engineering fields. This impression is entirely erroneous so far, at least, from the experience of one of the largest manufacturers of small steam engines in this country. The mechanical stoker and similar advances in steam engineering have made the small steam engine indispensable and more essential than ever before. This is particularly true in plants where steam is a source of power, for in such plants the small steam engine proves an auxiliary which is very hard to equal, both from the standpoint of economy and efficiency.

The Acme engine, manufactured by The Sterling Machine Company, of Norwich, Connecticut, has, during the past 20 yr., undergone improvement from time to time to meet the demands of the day for a rugged, simple and economical unit, and recently several interesting features have been added and a general description is given herewith.

These engines are of the vertical 2-cylinder, single acting, enclosed type with a balance rocking valve and are splash lubricated. They are built in 3 series of sizes, the small series being 2⅛, 3, and $3^5/_{16}$ by 3½ in.

FIG. 1. THE ACME STEAM ENGINE

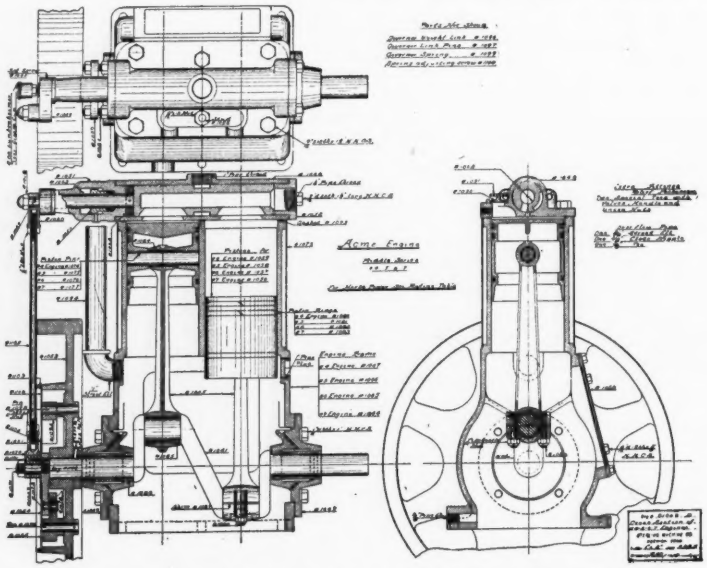


FIG. 2. SECTIONAL VIEWS OF THE ACME STEAM ENGINE

stroke. These small engines are identical in external appearance. The middle series is $3^5/_{16}$, 4, $4^9/_{16}$, and 5 by 5 in. stroke. These 4 sizes being also identical in external apearance and practically of the same weight. The large series of 3 engines is 5, 6 and 7 by 7 in., being also of the same external size and general appearance. This range of sizes covers all the applications to which these engines are especially adapted. Because of the extreme simplicity of construction, a valve which adjusts itself to wear, and the large bearing surfaces which are thoroughly well lubricated at all times by a splash of oil, they are especially well suited to drive mechanical stokers, for direct connection to small gear driven pumps, for driving rock drills and small friction hoists, any variety of belt or direct driven pumping machinery for contractors or irrigation purposes and for small plants such as laundries, creameries, etc., and it has been adopted in a number of instances to marine service such as lighting, driving ammonia compressors, ventilating fans, etc.

The character of internal construction is especially interesting, showing as it does the influence of automobile engine practice in many of the details. For example, the crank shafts are drop forged and ground to very accurate size, the connecting rods are of the popular I-beam section, bushed with bronze at both ends, the bearing cap on the crank end being held in place by castle nuts and cotter pins as is common in automobile work. The piston rings are of the diagonal cut type, 2 being placed above the wrist pin and 1 below. These rings are re-turned after cutting and ground to accurate size. The valve is a simple one-piece casting which is ground on the outside to fit an accurately bored chamber and is fastened to the extended valve stem with a cross key in just the same way that the ordinary Corliss valve is fastened. A further point of considerable interest is the matter of automatic cylinder relief valves which are built into the cylinder heads to relieve any water that might cause damage.

The governor is of a very simple type consisting of 4 main pieces. The action of the weights is modified by means of a hardened roller which travels in a milled arc. The entire governing mechanism is contained in an oil pocket, only the pin to which the lower end of the valve rod is connected being extended through; and inasmuch as this mechanism is on the outside of the flywheel, it is very readily accessible.

There are but 2 grease cups requiring attention, all other surfaces being amply lubricated by the internal splash. Provision is also made in the base of the engine for the elimination of the condensation which may collect. The leakage from the valve stem stuffing box falls into the engine base through the vent pipe at the end of the engine. The entire series of engines are built with new and accurate jigs on the interchangeable plan.

# FEED WATER HEATING AND FEED WATER HEATERS

THE efficiency of the steam plant is measured by the amount of power which is developed per pound of fuel burned. Of the heat given out by the fuel, some is lost in heating the boiler room, that is in radiation; another portion goes up the chimney; and the rest leaves the boiler in the form of steam and goes to the engine, where a portion is converted into work, but much the larger part leaves the engine in the exhaust. The exhaust, in fact, carries off not less than 4 times as much heat as is converted into work, and usually a good deal more than 4 times. This is due to the fact that in changing water to steam, the water takes on a large quantity of heat amounting to nearly 1000 heat units per pound, which disappears in pushing the molecules of water apart, in the formation of steam, while the steam, though no hotter than the water from which it was formed, carries off the 1000 heat units as hidden or latent heat. The exact quantity of heat which becomes latent varies according to the pressure at which the water is changed to steam, i. e., the boiler pressure; but at atmospheric pressure, the figure is nearly as great as 1000.

In exhausting a pound of steam from the engine, therefore, nearly 1000 heat units are carried off into the condenser without doing any useful work. Those heat units are discharged into the condensing water, causing it to become warmer, while the cold condensed steam leaves the condenser at a temperature much below that of the water in the boiler. In a non-condensing steam plant, the exhaust is discharged directly into the air, carrying off with it the latent heat, which will be given up afterwards when the vapor in the air is condensed, and falls in the form of rain. Naturally, the heat given up during the formation of rain is of no use to the engineer who originally lost it from his coal pile and put it into the water in the boiler.

There is, therefore, a large portion of the heat taken from the coal which leaves the engine with the exhaust steam; and any saving effected at this point is so much clear gain. The most natural way to save part of this heat is to put it back into the boiler as far as it can be done, and this is effected by means of the exhaust steam feed water heater.

In the average non-condensing steam plant, a portion of the exhaust discharged at atmospheric pressure and not less than 212 deg. temperature, may be brought into close contact with feed water in a tubular heater, or may be turned directly into a tank of feed water, as in the open heater; and as much of the heat as is required to heat the cold feed water up near to the temperature of the exhaust steam will be absorbed by the feed water and returned with it to the boiler. In a condensing steam plant, steam from feed and air pumps can be used for the same purpose. Even in the most improved modern turbine plant, there is enough steam from feed pumps to effect a substantial saving by heating feed water.

In purchasing a closed heater, about the first question the engineer usually asks is regarding the heating surface provided. The fact is, however, that large heating surface is one of the least important details of tubular heater design. Hundreds of experiments have been made by the most skillful engineers to determine the amount of heat which can be passed through metal sheets and tubes from steam to water; and yet no satisfactory results have been obtained, the figures of one engineer showing 3 or 4 times as great a transmission as those obtained in another set of experiments. It was finally recognized that heat transmission through metal surfaces has little to do with the kind or thickness of metal, but depends almost entirely upon the speed with which the water or steam is brought into contact with the surface, and the heated film taken away again and replaced with colder water. The same tube supplied with steam of the same temperature will heat the same quantity of water 3 or 4 times as quickly if the water is pumped rapidly along the tube. The figures obtained by experiment were of so little practical use that a few years ago makers of feed water heaters adopted by general agreement a standard of 0.3 sq. ft. per horsepower, and heaters of many makes have been constructed on this basis, regardless of the fact that with short straight tubes 3 or 4 times as much surface is required for the same heating effect as with corrugated or coiled tubes.

# COOLING BEARINGS

VARIOUS expedients are in use for cooling a bearing when it has become overheated. Although sulphur has sometimes been suggested, experience does not seem to show that this is good, and it would seem better to avoid it. A method used by some engineers who erect machinery, is to mix with a good oil a like amount of sapolio or Bon Ami, giving it a thin mixture with plenty of oil and heating slowly.

It is better not to use this until after the bearing is cooled, or, if a stop cannot be made, the speed should be cut down and the pressure on the bearing if possible, since it is a matter of regrinding the bearing with a very fine abrasive, and high speed and pressure is likely to result in too rapid action.

If the bearing is well fitted and the heating is caused by too great pressure, then the abrasive method is not good, and if the heating is caused by dirty or gummy oil, putting on brine or any salt in the oil will cut the dirt. Cutting in castile soap, so as to make a strong soap suds solution, will also be of assistance, and a stream of cold water over the bearings or the use of white lead mixed with the oil will frequently remedy the trouble.

If the heating is not great, mixing graphite with the oil or even putting in a certain amount of dry graphite will sometimes remedy the trouble without necessitating a shut down.

When water is used to cool the bearings, care should be taken that no sand or mud is contained, and it is better to use ice or snow packed around the outside of the bearing than water run through it, if possible.

In using white lead and cylinder oil, a pound of lead to quart of oil makes a good proportion. It is well to apply this after the bearing has been partly cooled down with water. It should be noted that the abrasives, such as sapolio, Bon Ami, rotten stone or soap stone should never be used on a babbitted bearing, only on bronze or steel.

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"IF YOU HAVE DONE little and worked hard, you have done more than if you had accomplished more and worked less."

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"THE FELLOW who thinks that his job is unimportant usually gets just that kind."

# STEAM ENGINE LUBRICATION*

By R. D. Tomlinson

IN numerous cases trouble in lubrication was due not to price paid or quantity used, but to the fact that the lubricant was unsuitable for the conditions of that particular engine.

Lubrication of pins and journals can best be accomplished by a gravity oiling system, for which there has lately been put on the market an oil filter and pump to be placed near the valve-gear side of the engine and driven from the rocker arm. This pumps the oil from a receiver below the floor up into the filter, from which the oil is pumped into a standpipe on the frame of the engine giving sufficient head to force the oil to the bearings and pins. For small- and medium-sized units, this makes a satisfactory arrangement, as the entire apparatus is so located that the operator can see what is going on without leaving the engine room.

In some locations the old gravity system may be desirable, but some kind of a system should be installed so that the bearings and pins of the engine can be practically flooded with oil to eliminate hot pins and journals. The engine will run 2 to 3 times longer without keying up (which proves that the pins and journals are not wearing rapidly) than would be the case if cups were used and drops of oil were fed to the pins and journals. Also if a little dirt gets into a bearing, the large quantity of oil passing through will wash the dirt away without harm.

On the other hand, if only drops are used, the probabilities are that the pins and journals will run hot and cause more or less damage if the attendant does not notice them in time to take care of them.

The main point in oil filters is to look out for the size of the filter. It should be large enough to allow time for the oil to filter properly while passing through.

### Cylinder Lubrication

CYLINDER lubrication is one of the most difficult problems with which the engineer has to deal.

Most cylinder and piston troubles are due to improper lubrication, frequently because the oil used is not suitable.

Variation in temperature of the steam is an important factor, and still more important is the quality of the steam entering the cylinder. There is less trouble with the high-pressure cylinder than with the low, for the steam is drier. Many cylinder oils will not properly lubricate if the steam is wet, and trouble is much aggravated where large engines run long on light load. The low-pressure cylinder steam is very wet and unless the cylinder oil used is compounded heavily with animal oils it will not form a film on the cylinder walls. Price is not a good guide to go by, for it frequently happens that a low-priced oil, which is properly compounded for the service, will absolutely cure troubles which high-priced oils fail to remedy.

A cylinder that shows evidence of improper lubrication, should be treated much the same way as any sickness; a competent engineer should diagnose the case and prescribe the proper oil to meet the conditions.

It frequently happens that the trouble is not with the oil itself but with the method of introducing the oil or the place where it is introduced. There are cases in which the oil pump or lubricator attachment was changed to some point on the steam line—sometimes 4 or 5 ft. from the cylinder—with good results. This gives an opportunity for the oil to become thoroughly mixed with the steam before entering the cylinder. In other cases the oil should be introduced close to the cylinder; it all depends on the conditions.

The whole matter simply reduces to a careful study of the conditions that exist and experimentation with the various kinds of oil and the methods of application until the proper conditions are secured. This, any intelligent engineer can do.

Much has been written and said about the necessity of just the proper quality of iron in a cylinder to make a piston run properly, and there is no question of the advantages of the iron in the cylinder and bull ring being of the proper degree of hardness, etc. But the writer has seen many soft-iron cylinders operate successfully without rapid wear with the use of properly selected cylinder oil that maintained a film of the surface of the cylinder.

One fallacy in connection with the subject of cylinder lubrication: It is quite common to reduce the quantity of cylinder oil used to the least possible amount necessary. This cuts down the oil bill, but in many cases it increases the internal friction of the engine, so that it requires much more steam, hence, increases the fuel bill. Engineers should remember that it is not the reduction of the oil bill or any other one item in a plant that counts; it is the reduction of the total cost of operating the plant that they should strive for.

*Abstract of paper read at the convention of the I. O. E.

# REMOVING EMULSIFIED OIL FROM WATER*

By Darrow Sage

WATER which in the form of steam has passed through the cylinders and steam valves of engines and pumps lubricated with cylinder oil, carries with it all the oil that has passed into the cylinders, some of it in the form of drops or small globules of pure oil and the remainder in the form of emulsified or finely divided oil in suspension. The emulsified oil gives the water a milky appearance similar to water that contains a quantity of air in suspension, but in the case of emulsification, this milky appearance does not leave the water, and the oil cannot be filtered out by ordinary methods. This finely divided oil must not be confused with the drops of oil, which are often seen floating on the surface of water condensed from exhaust steam, as these drops of oil may easily be removed from the water by collecting the mixture in a settling tank from which the water still carrying the emulsified oil can be drawn off from the bottom.

At present there are 3 methods of removing this emulsion, namely: Filtration through certain kinds of natural sand or crushed stone; electrical treatment; chemical treatment.

Each of these methods has its particular field, depending upon local conditions and plant equipment. Only the chemical method will be described herein.

The commercial name of the chemical used in this process is ferric alum (ferric ammonium sulphate). This comes in the form of lumps or crystals having a peculiar bluish tinge which turns a brownish-yellow color after exposure to the air. It is easily soluble in water and this property is used to introduce the proper quantity into the water to be purified.

From experience it has been learned that about 4 lb. of ferric alum will successfully clarify 10,000 cu. ft. of emulsified oil and water, and if this water is recovered at the rate of, say, 4200 cu. ft. an hour, the ferric alum should be added uniformly at a proportional rate. Not only must the rate of flow of the water and ferric alum be uniform, but care must be taken to see that the chemical is thoroughly mixed with the water to be treated.

A convenient way of doing this is to dissolve the necessary amount of ferric alum to last about 24 hr. in a barrel of water and permit this solution to flow or drip into the tank in which the return water is caught before it is pumped to the filter, as will be explained later. In making the ferric alum solution, care must be taken not to produce too strong a mixture, as a saturated solution of this chemical in water is very corrosive. It should never be mixed in greater proportions than 2 lb. to the barrel of water of about 50 gal., and where conditions will permit, less than this.

As soon as the ferric-alum solution and the water under treatment have been thoroughly mixed, a pronounced change can be noticed in the milky appearance of the water, caused by the action of the ferric alum, which coagulates the minute particles of oil suspended in the water, and thus produces a change that cannot be easily described but can be quickly detected.

After the action of the chemical has taken place the mixture is ready for filtration.

A filter for this purpose can be made from an ordinary tank partially filled with coarse, clean sand which has sufficient area to permit a flow not exceeding 15 cu. ft. an hour a square foot of sand bed. The sand should be about 2 or 3 ft. thick and the sides of the tank must extend above the top of the bed a sufficient distance to provide a separating space for the floating oil. Into this filter the water treated with the ferric-alum solution should be pumped and properly scattered about the surface of the sand bed so as not to wash holes therein and be allowed to pass out at the bottom of the bed through screens and perforated pipes to keep the sand back.

The emulsified oil being properly coagulated, will be caught by the sand and from the discharge of the filter clear water practically free from oil will be obtained. Where it is possible to arrange the filter so that the overflow can be caught, the drops of oil and coagulated scum can be washed out of filter by simply shutting the discharge valve from the bottom of the tank and permitting the filter to overflow its sides. The floating oil can in this way be skimmed from the top of the tank at regular intervals, but its use as a lubricant is not advisable.

By this method cleaning of the sand bed can be materially postponed, thus getting the equivalent of a longer life out of the filter. With a filter as above described, cleaning will be necessary about every 30 days when working up to its full capacity, assuming that there is no more than a normal quantity of oil in the water which passes through the filter.

Cost of operation of a filter plant of this size is small compared to the value of the water saved, as the present price of ferric alum is about 20 cents a pound and the cost of saving 10,000 cu. ft. of water would be 80 cents plus the cost of the pumping and whatever slight attendance is necessary to operate the pump.

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FIFTEEN HUNDRED people are killed and 5000 are injured annually as a result of fire.

# FULLER'S EARTH AS AN OIL FILTER

PRODUCTION of Fuller's Earth, by Jefferson Middleton, of the United States Geological Survey, has recently been published as an advance chapter from Mineral Resources of the United States, 1910.

The fuller's earth resources of the United States, says Mr. Middleton, have attracted considerable attention for several years, because of the increasing demand for this material for use as a clarifying agent for mineral and vegetable oils. The original use from which it derives its name, the fulling of cloth, is now of minor importance.

Fuller's earth was discovered by accident in this country in 1893. At Quincy, Fla, an effort was made without success, to burn brick on the property of the Owl Cigar Co. An Alsatian cigar maker employed by the company called attention to the close resemblance of this clay to the German fuller's earth, as a result of which the clay was tested and found to be fuller's earth, and the industry was developed. This discovery caused considerable excitement, and supposed deposits of fuller's earth were reported from a number of states. The material in most of these deposits, however, was found to be of no value as fuller's earth.

### Method of Clarifying Oils

THE principal use of fuller's earth in this country is in bleaching, clarifying, or filtering of fats, greases, and oils. The common practice with mineral oils is to dry the earth carefully after it has been finely ground, and run it into long cylinders, through which the crude black mineral oils are allowed to percolate very slowly As a result, the oil that first comes out is perfectly water white and much thinner than that which follows. The oil is allowed to continue percolating through the earth until the color reaches a certain maximum shade. Then the fuller's earth itself is clarified by a steaming process and used over again.

With vegetable oils, however, the process is radically different. The oil is heated beyond the boiling point of water in large tanks, from 5 to 10 per cent of its weight of fuller's earth is added, and the mixture is vigorously stirred and then filtered off through bag filters. The coloring matter remains with the earth, the filtered oil being of a very pale straw color.

American fuller's earths are better adapted than the English earths for use on mineral oils, but the English earths are superior for the treatment of fats and vegetable oils. In clarifying vegetable and animal fats with American earths a more or less disagreeable taste is left—just why has never been determined.

To show the growth of the American industry it is only necessary to state that from 6900 tons in 1895 the production increased to 33,486 tons in 1909. This was the maximum, the output for 1910 being 664 tons less. Florida was the leading producing state in 1910, furnishing 57.38 per cent of the total output, or 18,832 short tons. The other producing states, named in order of their rank in output and value in 1910, were Georgia, Aarkansas, Texas, California, Massachusetts, South Carolina and Colorado.

A copy of Mr. Middleton's report may be obtained on application to the Director of the Geological Survey at Washington, D. C.

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AN IRRESPONSIBLE position in a power plant may save you from a disagreeable call down but it will never make you an engineer.

# Questions and Answers

**To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.**

## THE CHIEF ENGINEER'S CATECHISM VII

WHAT causes priming in boilers, and how is it to be prevented?

2. What is the maximum temperature of feed water obtainable in a heater using steam from a noncondensing engine?

3. To what temperature should a live steam purifier raise the feed water?

4. Do you prefer a simplex, duplex, triplex or centrifugal pump for boiler feeding and why?

5. What size pump would you recommend for a 500-hp. boiler and how do you determine it?

6. What velocity would you allow to the water in the feed-water piping?

7. When is a pump steam bound and when air bound?

8. Where would you use screwed fittings and where flanged fittings in steam piping?

9. What type of valve would you use for a steam line and why?

10. How would you provide for the expansion in a steam line and how would you determine the amount to be taken care of?

(The best set of answers to these questions will be paid for at the regular rate, and the author of the second best will receive a prize of $3. Answers will be published in January issue, and all answers should reach Practical Engineer not later than December 1.—Editor.)

### Rain Water for Boilers

WE are thinking of putting in a couple of large cisterns here to store the rain water and use it in the boilers, and would like to know if rain water would pit a boiler or have any bad effect on it.

We use the Webster system of steam heating, so all of our steam is condensed for boiler use again. Allowing for what water is discharged in blowing off and draining them for cleaning, I estimate that we use about 15 per cent fresh water, our water being very hard, we have some scale to contend with, and have not been able to get a compound that would give perfect satisfaction. A. J. Baldwin.

A. In regard to the use of rain water in your boilers, it is not likely that using 15 per cent of fresh water will do any damage. Rain water, as ordinarily encountered, is so pure that it is likely to eat the iron. Any water has an affinity for a mineral substance and tends to take up minerals in solution. Where the water is too pure, fed into a boiler, it tends to dissolve some of the iron and thus cause pitting, but used as a supplement to the water that you already have in the boiler and which you say is somewhat hard, it would act as a corrective to the hardness of the ground water.

"HARD WORK, without the use of common sense to direct it, is waste. That is why there is always room for bosses."

## ANSWERS TO THE CHIEF ENGINEER'S CATECHISM V

BY WILLIAM E. DIXON

EXAMINATION of the firebox will not tell us all we want to know about our combustion results. It will not tell us, for instance, how much air is leaking into the setting. We may be getting good combustion but at the same time be using too much draft and therefore too much air. A mere look at the fire will hardly settle the question for us. Nor can it tell us how much heat we are throwing away up the chimney. And yet much may be determined from a glance into the firebox. If we see long dark red flames we may feel pretty sure we are producing carbon monoxide and therefore throwing good fuel up the stack. And we could not go far wrong in guessing that there was deficient air supply.

If we find, however, short light flames and an incandescent bed of fire, we may feel confident that we are getting good results. But are they the best? That is what we want to know; and a mere look will hardly tell us. If, however, we find heaps of dull red coke and thin patches of incandescent fuel with little or no flame, we know at once that too much air is going through the latter and almost none through the former. The best plan is to use the $CO_2$ machine, watching our fires in the meantime, also the draft gage. Then we shall soon learn pretty nearly what to strive for and what to avoid in the furnace.

One manufacturer of $CO_2$ machines (The Westover Co.,) gives the following data as a guide to furnace operation:

**Fire Colors and Temperatures**

| % $CO_2$ | Color of fire | Temperature Corresponding | % Loss |
|---|---|---|---|
| 14 | bright white | 2600 | 0 |
| 13 | white | 2200 | 1 |
| 12 | | | 2 |
| 11 | deep orange | 2000 | 3 |
| 10 | | | 5 |
| 9 | light orange | 1750 | 7 |
| 8 | | | 10 |
| 7 | full cherry red | 1400 | 13 |
| 6 | | | 17 |
| 5 | dull cherry red | 1150 | 23 |
| 4 | | | 32 |
| 3 | dull red | 1000 | 47 |
| 2 | dark red | 900 | 77 |

While this may be useful as a general guide and true in a general way, we all have to deal with our own special conditions. Various coals require different treatments to give similar results. Each man wants to get the best results in his own plant. General rules must then be supplanted by the instruments which will tell us just what we are doing.

2. The alternative to comparison by cost of operation is comparison of boiler tests. In a boiler test the very best

conditions obtain. The boiler has been cleaned carefully inside and out. The feed water is regulated exactly to requirements and the operation of firing is watched with care. There is always a temptation to take coal from the best corner of the pile—also diverse other temptations such as frequent opening of blow-off valve, "sugar trust" operation of scales, etc., but as these are really no part of a boiler test we will pass them by for the present. If we want to know the very best a boiler can do, then a boiler test is the thing we want, but if for practical every day purposes, it may lead us astray. One type of boiler might, in practical operation, gather more soot and scale than another. The first type might win in a test, the second might win in the long run.

In the test, meter readings, gage readings, etc., are taken more carefully than is usual in every day practice, and the quality as well as quantity of steam is recorded. In many plants it is impossible to know exactly what the real output is. In an electric plant fully equipped with wattmeters, water meters, etc., this can be done, and yet in many of these steam is used for other purposes than generation of power and is seldom metered. So that the basis for comparison is much less definite in comparison by actual operation results than by boiler tests.

Again, in a boiler test, repairs are not taken into consideration, while they must be in practical operation. A combination of furnace and boiler might show fine results in test but prove very uneconomical on account of large bills for repairs. It would seem, then, that each method has advantages. And the wisest course would be to combine the methods in making comparisons.

3. If it is merely a case of securing economical combustion, compressed air will give best results. But in most small plants it will mean large expense to equip for compressed air, while steam is easily obtained, and in such case steam would probably prove the better choice. In a large plant where the installation of a compressor would not be such a burden, or in a plant where air is available, it will be found preferable.

4. The fuel value of natural gas is stated in B. t. u. per cubic foot, though some authorities state it in B. t. u. per 1000 cu. ft. The heat value of natural gas varies with location of the well, and the product of one well will vary considerably from time to time, but the value will seldom fall below 800 or rise above 1200. Most wells will average between 1000 and 1100.

5. Allen and Bursley give the following as the average probable actual efficiencies of various classes of engines.

| | |
|---|---|
| Small steam engine..... | 8.7 per cent |
| Small gas engine..... | 19.5 per cent |
| Large condensing steam engine | 19.3 per cent |
| Large gas engine..... | 28.0 per cent |

In burning gas under a boiler there are large losses up the stack, by radiation, etc., so that the boiler will probably not absorb over 70 per cent of the heat energy in the gas. This is all it can deliver to the engine so that the combined efficiencies will be in case of small steam engine, $0.70 \times 8.7 = 6$ per cent; large condensing steam engine, $0.70 \times 19.5 = 13.5$ per cent.

6. If conditions were such that the decision between horizontal and vertical boilers depended upon preference, then I should choose the horizontal. By placing a manhole in the front head under the tubes in addition to the one in top of shell, the boiler becomes accessible for thorough cleaning and inspection. Only a small part of the interior of a vertical boiler is visible and the water leg and tubes are inaccessible. It is well known that combustion is poor when hot flames strike cold surfaces. This seems inevitable in case of the vertical boiler; while it can easily be prevented in case of the horizontal by raising the boiler or by a fire arch, or even a Dutch oven if necessary.

7. Various things may happen to raise the steam pressure above a safe limit. The damper may stick open, the feed may stop, the engines may shut down, or load suddenly fall off. In such cases there must be some means of automatically relieving the excess steam generated until conditions again become normal. To do this we use the safety valve.

If chemically pure water were easily procurable, possibly we should not need a blow-off valve except to empty the boiler for inspection, etc. But all the water we can find for boiler feed contains more or less foreign matter, vegetable matter, mud, silt and various minerals held in suspension. When the water is evaporated this solid matter is left behind. As more and more water evaporates, more solids accumulate in the boiler. They begin to deposit upon the tubes and heating surfaces. If this process is allowed to continue the transfer of heat to the water would be impeded, the plates and tubes would overheat, ruining the boiler or possibly causing an explosion. To prevent this the blow-off valve is opened at stated intervals and this accumulation is blown off.

8. There are 4 types of stokers; spreading, chain grate, inclined grate and underfeed. The spreading type pulverizes the fuel and blows or throws it upon the fire from above and in front. In the chain grate type there is a grate built in the form of an endless chain. The movement of the chain on the upper side is from front of furnace to back. Fuel is fed upon the front of the grate and is carried toward the back by movement of the grate, burning as it goes, ashes and clinker falling off at the back end. In this type the gases distilled from the green fuel pass over the incandescent bed further back and are there burned more or less completely. In the inclined grate, fuel is fed at the top of the grate and moved down the incline, burning as it goes, by the rocking of the grates, ashes and clinker being dumped at the bottom of the incline. As in the chain grate type, the gases distilled from the green fuel at the top of grates are made to pass over and mix with the gases from the incandescent portion of the fire. The fuel in the underfeed stoker is pushed under the fire and is burned as it rises to the top. Forced draft is introduced through the green fuel, the air mixes with the gases being distilled and then passes through the incandescent bed to give mixture of air and gases so as to complete combustion as they pass through the surface of the fire, which is uniformly at white heat. Ashes and clinker are pushed to the sides or rear by movement of new fuel introduced.

9. If a plant is a temporary one like stone crusher, or sawmill, let the stack be iron. If plant is a permanent one use a brick chimney, it will require no painting or other repairs for years. Concrete chimneys—I prefer to let the other fellow experiment—unless built with utmost care they will collapse, and they appear to have their capacity affected by weather conditions more than other types.

10. If this question means literally what it says, there seems to be no answer. Computing from Dawson's tables, a 3-ft. chimney 90 ft. high would have 6 cu. ft. per hp. while one 6 ft. dia. and 160 ft. high gives 7 cu. ft. per hp. Turning to Kent, a 3-ft. chimney 80 ft. high has 3.67 cu. ft. per hp., while one 4 by 90 ft. has only 3.43. Mr. Brinkerhoff in September number, allows 12 sq. ft. chimney area for 500-hp. boilers, 20 sq. ft. for 1000 hp. and 36 sq. ft. for 2000 hp. On basis of chimney 150 ft. high, this would give in the 3 cases respectively, 3.6, 3, and 2.7 cu. ft. per hp. This indicates that not only do authorities differ, but that none of them seems to know that there is

any fixed relation between cubic feet of stack and boiler horsepower.

If the question refers to cubic feet capacity per hour, then we can find some relation to boiler horsepower, if we can assume a few conditions. Let us assume that 3 lb. of coal are burned per boiler horsepower, that it takes 24 lb. of air to burn one pound of coal, and that the flue gas temperature is 400 deg. Burning 3 lb. of coal would give us then about 75 lb. flue gas. Now this gas at 32 deg. would occupy 12.5 cu. ft. per lb. or a total space of $75 \times 12.5 = 937.5$ cu. ft. At 400 deg. it would occupy a much larger space because it would have been expanded by the heat. Its volume will have increased directly as its absolute temperature. At 32 deg., its absolute temperature was $460.6 + 32$. In the flue its temperature will be $460.6 + 400$. Its temperature has increased, then, from 492.6 to 860.6. Since its volume has increased in the same ratio, the volume of flue gas will be $937.5 \times 860.6 \div 492.6 = 1637.8$ cu. ft. Under these conditions then a chimney would have to be able to handle about 1650 cu. ft. per horsepower per hour.

If the area in sq. ft. per horsepower is meant, we shall still find it to vary somewhat with the size of the installation, with fuel to be burned, etc. Mr. Brinkerhoff's figures given above would allow for a 500-hp. plant 0.024 sq. ft. per hp.; for a 100-hp. plant, 0.020; and for one of 2000 hp., 0.018.

By C. B. Hudson

1. One cannot determine accurately by the state of the firebox whether good combustion is being obtained or not. One may determine from the firebox whether sufficient heat is being generated to distill properly and consume the volatile gases, yet good combustion requires that 2 atoms of oxygen enter the furnace for each atom of carbon consumed in the furnace and this cannot be told from the state of the firebox.

2. Boiler tests for practical purposes are used as a means of determining whether the boiler and furnace are performing at a maximum efficiency, that is, if the largest amount of steam possible is being obtained from a minimum expenditure of heat units. This cannot be shown from comparison of cost of operation as the heat value of the coal might not be the same under all conditions.

3. As between air and steam for atomizing oil fuel, air will probably be more efficient from a heat standpoint, but will require expensive apparatus for compressing and heating it; it will also be more efficient in an overload than will steam in the same furnace, as it will supply much of the oxygen needed for combustion, while steam will simply take up space needed for combustion. Steam, on the other hand, comes to the furnace with a minimum of apparatus for its control and furnishes its own heat. The choice for general conditions depends on the cost of operation and would seem to favor steam as an atomizing agent.

4. The heat value of natural gas is stated in B. t. u. per cubic foot, and the value runs from 800 to 1100, and 1000 cu. ft. will equal approximately 57.25 lb. of coal.

5. In burning natural gas under a boiler the heat generated is exposed to the same losses between furnace and engine shaft as is the heat generated by coal or other fuel in the same manner. The chief loss of heat is that which is exhausted into the condenser or atmosphere and is assumed by one authority to be 45 per cent of the total heat generated by the furnace; other losses due to radiation, etc., bring the total losses up to 80 or 85 per cent, which would give an efficiency of 15 to 20 per cent. The chief source of loss in a gas engine, as in a steam engine, is the heat exhausted to the atmosphere, and will amount to an average of 55 per cent of the total heat in the fuel, due to imperfect expansion. While there are other losses, the gas engine should be able to show at least a 2 to 1 efficiency over a steam plant using the natural gas fuel.

6. The writer prefers the horizontal type. With the vertical type, unequal expansion of the tubes and shell tend to set up strains between the upper and lower tube sheets; scale is difficult to remove from the crown sheet and an accumulation of scale at this point tends to make leaky tubes. The water leg is a source of trouble from mud and scale. The horizontal type is more accessible, easier to keep clean and owing to its brick setting is exposed to a more even temperature which keeps down undue strains.

7. The safety valve is a necessity, as it prevents the pressure from rising to a point in excess of that which the boiler will safely stand. The blow-off valve is also a necessity as a means of drawing the water from the boiler at times of inspection, also to remove sediment which would otherwise become baked to the shell, which might cause the plate to be bagged.

8. There are 3 principal types of stokers, the underfeed, overfeed, and chain grate; while there are many modifications of these types, the principle remains the same. The Jones and Taylor stokers are good examples of the underfeed type, the coal being pushed into the furnace under the fuel bed by means of rams or plungers; the coal is coked by the hot bed of fuel over it and in turn is forced to the top by fresh fuel. The Roney and Murphy are good examples of the overfeed type, in these the fuel is pushed in at the top of an inclined grate and is gradually worked down by gravity and the action of moving bars or fingers mechanically driven, the action being so timed that in passing from the top to the bottom of the grate the combustible elements are consumed and the refuse passes into the ash pit. In the chain grate stoker the fuel is taken from a hopper at the front and is carried by a traveling grate through the furnace from front to rear, the speed being so timed that the fuel is consumed in passing and the refuse is dropped into the pit at the rear. All these types are mechanically driven and the fuel is regulated according to the rate at which the boiler is being worked.

9. Everything considered, a brick chimney is thought to be the best. A greater draft can be procured on the same flue temperature with a brick than with a steel stack, as the intensity of draft depends on the weight of the column of heated air as compared with a like column outside the chimney, and the brick will radiate less heat than the steel. While the brick stack is higher in first cost, the cost of upkeep is comparatively nothing as compared with a steel stack, which requires protection from the deteriorating effects of the weather. A concrete stack compares favorably with a brick one if built of cement blocks, but a reinforced cement stack sometimes cracks.

10. The height of a chimney depends on the draft required, while the area depends on the volume of gases to be conveyed from the furnace. Allowing for friction, etc., one boiler horsepower will require from 3 to 3.5 cu. ft. of stack.

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### Changing Governor Speed

THE question is raised whether the speed of a governor on a Corliss engine can be changed without changing weights or the speed of the engine. I would like to hear from readers of Practical Engineer on this point.

M. J.

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"To have the courage of your opinions is a great thing. It is a greater thing to have an opinion which is worth being courageous about."

### Loss Due to Ground

THE insulation resistance, or rather a ground was tested with a Weston voltmeter having a resistance of 14,994 ohms, when connected across the line the voltmeter gave a reading of 220 volts. When the negative line was connected to the ground through the voltmeter the reading was 155 volts, thus the voltage of the ground on the positive side was 65.

What is the current in amperes through this ground?

The negative side has a ground of 70 volts, what is the loss in amperes in these grounds?

J. R. D.

A. In order to find the resistance at the ground of the positive wire, with the values of voltages as you have given them, we have the proportion: Voltage over the voltmeter is to the voltage over the ground as the resistance of the voltmeter is to the resistance of the ground, or, in this case, 155 is to 65 as 14,994 is to the ground resistance. The ground resistance on the positive side would then be about 6288 ohms.

On the negative side, taking the other value of voltage, we have: 70 is to 150 as 14,994 is to the resistance of the negative ground. The resistance of the negative ground would then be about 33,560 ohms. The leakage between wires would then be the voltage divided by the sum of these 2 resistances, or 33,560+6288. This would be 220÷39,848, or about 0.0055 of an ampere.

### Water Wheel Power

WHICH will give me the greater power, a water wheel 6 in. in diameter supplied by a ¼ in. nozzle with water at 80 lb. pressure and belted to grinder which is to run at 100 r.p.m., or a wheel 24 in. in diameter supplied by a ¼-in nozzle with water at 80 lb. pressure, belted to the same grinder to run at 100 r.p.m.

M. W. E.

A. So far as the power delivered is concerned, it makes no difference whether you run a 24-in. wheel or a 6-in. wheel belted to your grinder. In either case the wheel should run so that the bucket velocity is half that of the spouting velocity of the jet. The spouting velocity of the jet at 80 lb. pressure will be 108.7 ft. per second. As the circumference of the 6-in. wheel is 1.57 ft., it would have to run at 34.6 revolutions per second, or 2075 revolutions per minute in order to give the best results. The 24-in. wheel has a circumference of 6.28 ft. and would, therefore, have to run at 8.7 revolutions per second or 519 revolutions per minute.

The belting proposition would, therefore, be much better from the 24-in. wheel, because you would then have to belt down only from 519 to 100, which is a reasonable speed change, while with the 6-in. wheel you would have to belt down from 2075 revolutions to 100, which is an unreasonable speed reduction and would cause a great deal of slipping and loss of power in the belt.

### Steam Loop vs. Trap

OUR superintendent and myself had some discussion as to which is more economical, a steam loop or a steam trap to take the water away from the separator, and if the loop is, why are not more of them used instead of traps?

We are installing a large new plant and do not know which to put in, loops or traps, as several of the engines will be located some distance from the boilers.

W. J. S.

A. The steam loop and steam trap are for different purposes. The steam loop is for taking condensation from a heating system and returning it to the boiler without the use of a steam pump. The trap is simply for the purpose of draining away condensation from the separator. The steam loop would not be suitable for taking condensation from separators located at a distance apart, because the loop in order to work satisfactorily becomes too large an apparatus to work separately on each separator and would have to be located too far from the separators to drain them satisfactorily. The trap is the right apparatus for you to use.

### Draining Heating System

TROUBLE with the returns, as mentioned in the October number, under the above title, can be overcome by using the steam loop, which is in operation in many plants under similar conditions. The accompanying sketch gives the general arrangement to take care of several radiators.

Steam and condensation enter the vaporizer and what water enters is broken up on passing through the perforations of the inner tube and passes out with the steam as a wet vapor. The vapor rises and enters top of receiver made of 4-in. pipe, which should be placed

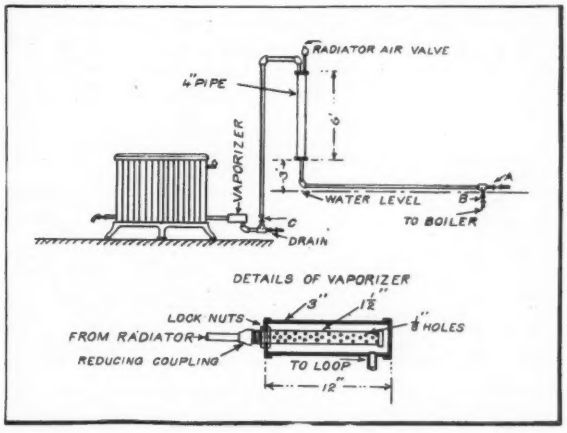



FIG. I. STEAM LOOP SYSTEM FOR RADIATORS

in a comparatively cool room or on outside of the building. This receiver acts as a condenser and a column of water will form in the receiver and pipe to the boiler, which when of sufficient height will start a flow to the boiler. To start the loop, close the valve C, and blow steam through radiator and out through drain valve under C. When you get a good flow of comparatively dry steam open C and close drain and with valve B closed, open A, and as soon as steam flows through A, close it and open B to boiler. The air valve on top of 4-in. pipe receiver should be kept in good working condition and valves B and C left open full while the loop is in operation.

C. H. Reynolds.

### Proper Place to Feed Compound

AT our boiler plant we are feeding boiler compound through the feed-water pump suction pipe. We have a great deal of trouble on account of sediment and scale choking the pipes from the pump to the boilers. Does feeding the boiler compound at this point cause this trouble, and would it help matters any to put the

compound into the boiler feed line at a point just a few feet from the boilers? Where do you consider the best place to put in compound?

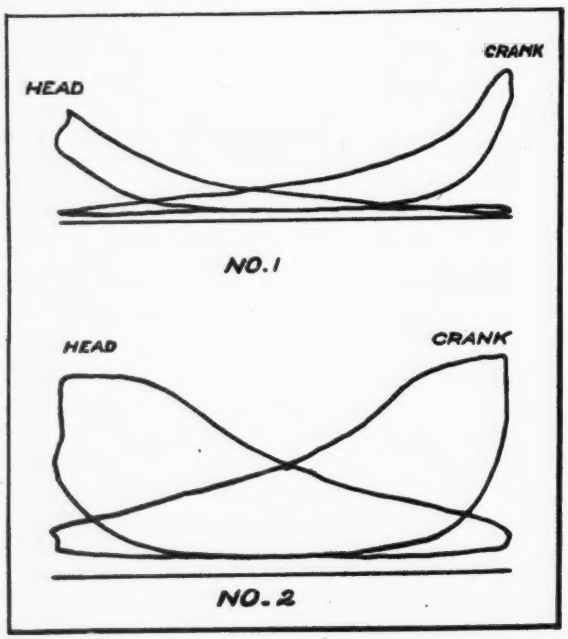
Our water is obtained from Scioto River. It is rather muddy at the river but is pretty well settled before being fed into the boilers. R. W. E.

A. Some engineers have often been able to overcome this difficulty by the feeding of the compound into the discharge pipe of the boiler feed pump at a point as close to the boilers as possible, thereby preventing precipitation in the suction pipe or in the feed line proper.

Presence of even a moderate quantity of suspended matter in the feed water is more often than anything else responsible for the trouble. This suspended matter may not all be present in the water obtained from the original supply, but in passing through the heater waters of this type, because of the temperature reached in the heater, throw down precipitation of more or less of the carbonates of lime and magnesia contained in the water, thus giving suspended matter, which, unless it is removed by the use of a filtering medium or by settling out in the heater itself or in a settling tank, may cause trouble.

### Jog in Diagram

WHAT is the trouble with card No. 2 at the left and how can I remedy it, and any other defect you may find? I notice admission is late on crank end, this can be overcome by moving the valve on this end, can it not? What causes the loop on card No. 1 on release, also curl on head end steam line?




CARDS FROM ERIE ENGINE

Card No. 1 is the friction load with a back pressure of 2 lb., card No. 2 was taken when the engine was loaded and subjected to a back pressure of 5 lb. The engine is an Erie, running at 195 r.p.m., non-condensing. V. H.

A. Concerning the indicator diagrams sent in by V. H., the jog in the admission line of the head end diagram, and also in the release of the crank end are caused by the drum spring being too weak.

The tension of this spring should be sufficient to keep the cord always stretched tightly. The method of adjusting the tension of the drum spring depends, of course, on the kind of indicator used. If it is a Crosby proceed as follows: Remove the drum by a straight upward pull; then raise the head of the spring above the square part of the spindle and turn it to the right for more tension, or to the left for less tension; then replace the head on the spindle.

Regarding other defects in the cards, not much need be said, except that cutoff occurs a little earlier on the crank end than it does on the head end. Otherwise they compare favorably with the average of indicator diagrams. C. F. Swingle.

### Steam to Heat Water

WE have quite a few hot water tanks heated from about 50 to 180 deg. by live steam at 45 to 60 lb. gage pressure; also a large swimming pool, heated from 50 to 75 deg. at the above pressure, in both cases the steam goes directly into the water through a nozzle. About how many lb. of steam will it take in each case to heat, say, 1000 gal. A. F.

A. To heat a pound of water from 50 to 180 deg. will require 130 heat units and from 50 to 75 deg., 25 heat units. A thousand gallons of water will weigh 8330 lb. For raising to the 180 deg. this would require $8330 \times 130$, or 1,082,900 B. t. u. For raising this amount to 75 deg. would require $8330 \times 25 = 207{,}250$ B. t. u.

It will not make a great deal of difference whether the steam is at 45 or 60 lb. pressure, but for 45 lb. the total heat would be 1171.2 heat units and this steam would be condensed and cooled down in the case of 180 deg. to the temperature of the water. The heat given up would then be $1171.2-(180-32)=1023.2$ B. t. u. given up by a pound of steam. If the water were heated to 75 deg. the heat given up would be $1171.2-(75-32)$, which would be 1128.2 B. t. u. per pound of steam. In case of 60 lb. steam being used, the only difference would be that each pound of steam would furnish 4½ more heat units on account of its total heat being 1175.7 B. t. u. Then to find the pounds of steam necessary at 45 lb. to heat up to 180 deg., divide 1,082,900 by 1023.2, giving 1060 lb. of steam required. In case 60 lb. steam was used you would have $1{,}082{,}900 \div 1027.7$, which would call for 1055 lb. of steam. If heating up to 75 deg. we should have $207{,}250 \div 1128.2$ for 45 lb. steam, which would give 184.3 lb. and divided by 1132.7 for 60 lb. steam, which would give 183 lb. of steam required.

### Condenser Problem

I WANT to condense 11,000 lb. steam an hour, maintain a 25-in. vacuum, the temperature of the water entering the condenser being 95 deg. F.

How many square feet of surface must the condenser contain?

How much water will be required?

What size dry vacuum pump will be needed?

If the temperature of the condensing water was 70 deg. instead of 95 deg., would a smaller condenser do, or would it simply require more water at 95 deg., disregarding hot-well temperature?

What is considered good practice in steam consumption for a simple Corliss engine, slow speed, operating condensing or non-condensing?

What is the steam consumption of a simple high speed engine operating condensing and non-condensing?

What is the steam consumption of a small high speed marine type engine, automatic, at about 550 r.p.m., non-condensing and condensing?

Does it require a larger condenser for a plant operating compound engines than a plant operating simple engines?

The accompanying sketch shows the arrangement of the surface condenser, exhaust main and vacuum reboiler. The reboiled water is used for ice making.

What I would like to know is, how much larger would the dry vacuum pump have to be to take care of the air and vapor given off by the reboiler than if there was no reboiler attached to the condenser, also how much more surface ought to be provided in the surface condenser to care for the vapor, etc., given off by the reboiler and the exhaust steam to the condenser after leaving the reboiler?

Dry vacuum pump to be crank and flywheel type and steam driven; from the size you calculate on, you can approximate the amount of exhaust steam passing through the reboiler to the condenser.

R. H. K.

A. To determine the surface required in a condenser we have as follows: The surface equals the weight condensed per hour times the heat taken from each pound of steam, divided by a constant and by the average difference between the temperature of the steam and that of the cooling water. The heat taken from each pound of steam will be that required to condense it, plus whatever is taken out in cooling the condensed steam below the temperature which it had as steam.

Usually the temperature of the water will be found some 10 deg. below that of the steam from which it was condensed, so that the heat taken from a pound of steam may be considered as the latent heat of evaporation plus 10. The average difference in temperatures is found by adding together the initial and final temperatures of the cooling water and dividing by 2, and substracting this from the temperature corresponding to condenser pressure.

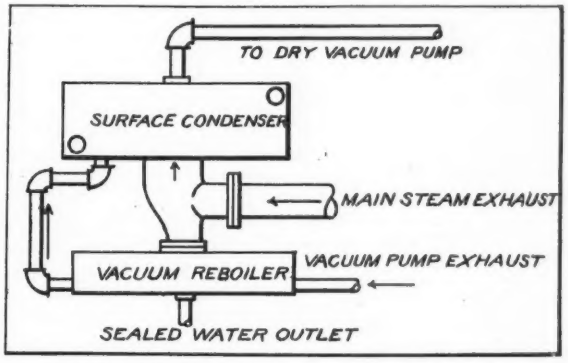
Taking up your problem, we have the latent heat of evaporation at 25 in. vacuum is, from the steam tables, 1021 B. t. u., and this plus 10 gives 1031. We must assume some final temperature for the cooling water and usually this will be not over 120 deg. for satisfactory operation. Then we add 120 and 95, and divide by 2, giving us 108, and subtract this from the temperature of steam at 25 in. vacuum, which is 134 deg. F., giving an average temperature difference of 26.

The constant to be used in this equation is found from tests on condensers to be 250 for plain condenser tubes and 300 for corrugated tubes. We then have 1031 × 11,000 divided by 250 and by 26, gives 1750 sq. ft. of surface needed. If the water were taken at 70 deg. instead of 95, we should have 120 + 70 + 2 gives 95, and this subtracted from 134 gives 39, and the surface required would then be 1031 × 11,000 divided by 250 and by 39, which would give 1165 sq. ft. needed.

To get the water required we multiply the heat taken from each pound of steam by the total pounds condensed, and divide by the temperature range of the cooling water. This tempearture range, if the water be at 95 deg. on entering and 120 deg. on leaving, will be 25 deg. We shall have 1031×11,000÷25, which will give us 454,000 lb. of cooling water required per hour. If the cooling water comes in at 70 deg., the temperature range will be 120—70=50 and the cooling water required will be 1031×11,000÷50=227,000 lb. per hour.

The rule from practice is that the capacity of the pump per hour should be 25 times the volume of the condensed steam. This is for vacuums of 27 in. and lower. It would call for a pump capacity in your case of 178½×25=4465 cubic feet an hour. Multiplying by 7½ and dividing by 60 gives 557 gal. per minute, which at 60 double strokes would mean 4.64 gal. each single stroke, which would call for a 10 by 12 pump.

This checks out fairly well with the figures given by the manufacturers of dry vacuum pumps. They rate these pumps in cubic feet capacity per hour and give the capacity of a 10 by 12 pump cylinder at 100 revolutions at 157 cubic feet per minute.




ARRANGEMENT OF CONDENSER AND REBOILER

In your case what is needed is 4465÷60=74.3 cubic feet per minute, and a 10 by 12 running at 60 revolutions would give just about this capacity. The steam cylinder is made half the diameter of the pump cylinder, giving a pump 5 and 10 by 12 in. The cylinder 5 by 12 at 60 revolutions would use 221.7 lb. of steam per hour, allowing that it takes 50 lb. of steam per horsepower hour.

The pump can, of course, run with reasonably early cutoff because it is a crank and flywheel pump. The capacity added to the condenser would, therefore, be 222÷11,000, which would be 2 per cent, an amount which need not be taken into account, as we have made considerable allowances already for slip and leakage. It would not, therefore, require a pump any larger for the use of the reboiler than without. The only difference might be that you would have to run at 63 revolutions instead of 60, which it would stand without any difficulty.

The figures already given answer your question as to the effect of reducing the temperature of the cooling water on size of condenser needed and cooling water required.

As to steam consumption for a simple Corliss engine, noncondensing, at its rated load, a good steam consumption would be 30 lb. per horsepower hour, and condensing 24 lb. For a simple high speed engine noncondensing, 35 lb. and condensing 30 lb. For a small high speed marine type, noncondensing, 45 lb. and condensing 40 lb.

As to the condenser for a compound or a simple engine you will see from the computations already made that the kind of engine has nothing to do with the size of condenser needed. It is simply the amount of steam to be condensed.

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"If you respect your work you respect yourself."

# THE ENGINEER SON'S REPLY TO HIS FATHER

## GETTING A START,—AS WORKED OUT BY THE KID

DEAR FATHER:

I received your very welcome letter in due time and while I was more than glad to hear from home, yet, your communication was a severe shock. You will admit that when one has mastered the intricacies of an advanced course in Mechanical and Electrical Engineering at the Bergville Technical Institute, it jars considerably to be told that one has to go back to the beginning again and start all over on the steering gear of a wheelbarrow.

Several of the boys who graduated with me have secured excellent positions with various firms throughout the country where they could immediately enter on a career worthy of their education. In fact I had about decided to accept a position as assistant superintendent with the Du Plainville Automobile Works, where I could really show what I know. True I never was in a position of authority before, but I believe I know all about it, for I took a 4-months' course at "Tech." in "Advanced Theory and Applied Practice of Shop Management" and stood very high.

Now, in view of these facts, father, I was somewhat loath to consider your letter seriously. I followed your first suggestion, however, to go out in the country some place and read your letter over and think it over. So I took the interurban out to Calamity Hill, went over into the grove and sat down under a massive white oak. At my feet lay Daneville, with the clouds of escaping steam and immense volume of dense smoke belching from countless stacks. I studied there and read your letter alternately till noon, and feeling hungry went over to a farmer's home and had a good old fashioned dinner, the best I've had since we left the farm at Sussex. There was chicken—Real Chicken. The feathers were still blowing around the yard, mashed new potatoes, green peas, pickled beets, and apple pie. Father I almost made a fool of myself from eating so much. But when one has lived on cold storage hens several years old, vegetables that are dried up like corks, canned beans, canned corn, canned peaches, canned sardines, embalmed beef, smokeless ham, codfish balls, stewed prunes and store mince pies, for 4 years, one is justified in going the limit when he bumps up against a genuine feast.

After dinner the old farmer and I got to talking on the tariff, reciprocity, etc., and other things I don't know anything about and finally to the civil war. He was with Gen. Grant and couldn't say enough about the way Grant did things. So in a burst of confidence I showed him my letter from you. He pulled his tin spectacle case out of his pocket, settled down comfortably in the big rocker on the porch and began to read. When he had finished, he handed the letter back, filled his pipe, puffed it a few times in silence while he looked out over his fields; then turning to me and tapping the palm of his massive left hand with the huge index finger of the right, he said:

"Son, yer dad's right. I don't know nothin' about this 'ere Tecknickle business only what I read in the papers, but I do know all about Gen. Grant. I fit with Grant when he was an Illinois colonel, down through Ft. Donaldson, Ft. Henry, Shiloh, Vicksburg and all the rest of them. Then we went East. I went through the Richmond campaign with Grant. I was his orderly. I held his horse at the McLean house at Appomattox while he and Gen. Lee signed the papers. You can't tell me nothin' about Grant. I know what he could do. You can't tell me nothin' about Lee. We all know what he did do. But when your dad tells you to 'fight it out on this line if it takes all summer,' you take your dad's advice.

"I never saw you before, but you look like you ought to be able to push a wheelbarrow, and if your dad says to start that 1000-mile trip on the business end of a wheelbarrow, why, I'd say, to take his advice."

Well, I came back to my room and canned meals. That canned meal proposition helped me along considerable. So I packed my trunk, putting my diploma away down in the bottom, as you said, and started for the smoke stacks at Daneville. Before I looked for a place to board I hunted up a situation,—well perhaps you would call it a job. I went to the engine room of the Daneville Mfg. Co. and asked the chief engineer if he had a job.

"No," he said, "I don't want a secretary today."

"Well," I said, "I don't want that kind of a job."

"Boy," said he, (and that hurt, for I'm 24 now), "Boy, the only thing I'd want now is a laborer to wheel coal and clean out the ashes and ——."

"Well, I'm you man," said I.

"But it only pays $1.75 a day," said he, and when I told him I didn't care if it only paid $1.75 a week he said:

"Kid, you must want a job awful bad, but I think you're a quitter. You won't last a week."

That made me mad all through. It's bad enough to graduate from a technical institute after 4 years hard work; and hard to be called a boy and a kid when I've voted three times, but when he called me a quitter that was the limit. I bluffed up to the chief as big as life and said: "Here, you call me a quitter or a kid again and I'll make you take it back."

"He looked at me a minute and then laughed. "What's your name and where did you come from, and what have you done for several years past?"

I told him my name and also that it didn't make any difference to him where I came from or what I had done; he had a job and wanted a man and I had no job and wanted one. So he showed me the wheelbarrow and the beginning of that 1000-mile ladder.

Father, that first day killed me—almost. I wheeled coal as fast as I could but the fireman burned it up as fast as I got it in on the floor. Finally I got enough ahead so I could wheel out some ashes. Nobody had touched them since the last fellow quit, the day before. The fireman got gay and said I was no good, so I hit him, and after that we got along bully. He even showed me how to handle a shovel, and how to pull the ashes out of the pit with the ash hoe.

After six o'clock I got a boarding place and it didn't need any soothing syrup to induce me to go to sleep. There were blisters on my hands the size of hazelnuts. Next morning I was stiff and sore and felt like throwing up the job. But the chief had called me a quitter and I decided to "show him." So when he came out and found me on the job again he said: "Well, Mac, I guess you want that job awful bad or you wouldn't come back."

I found an old scoop with a broken handle, so I put one in about 10-ft. long made of 1-in. pipe, after I had worked hard to get a few barrows of coal ahead,

so now I can shovel the ashes from the ashpit direct to the wheelbarrow and this saves a lot of time and work. Then I thought that it was a poor rule that wouldn't work both ways, so when I took a load of ashes out I'd bring a load of coal in. That saved some more. The chief came out several times and watched me, but didn't say a word. Maybe he heard what I did to the fireman. But father, I'm going to "fight it out on this line if it takes all summer," and I hope it does.

Affectionately your son,
Donald Cameron MacDougal.

## DEVELOPMENTS IN REGARD TO THE CHRISTIE ENGINE

WE have been endeavoring to obtain from the Christie Engine Co., some data as to tests which may have been made on their engine described in Practical Engineer for July. It was our understanding that as soon as the brake was ready, complete tests would be made to find out the facts so far as steam economy is concerned.

We have written to them from time to time to keep in touch with the matter, but have had no data until recently comes a booklet entitled, "Description and Philosophy," but containing nothing which has not already appeared in the company's literature with the exception of a single leaf giving some tests by Prof. F. C. Vincent of Everett, Wash.

The data from these tests are that the engine was run at constant speed of 104 r. p. m., steam pressure being 115 to 125 lb. Water used by the boiler was accurately weighed according to the statement of the test, and the run was for 5 hr. Temperature of the exhaust measured not over 12 in. from the cylinder remained constant at 104 deg. F., which according to the steam tables corresponds with 1.19 lb. absolute pressure. Indicator cards have been furnished us which check with Prof. Vincent's figures. He gives an average indicated horsepower of 66.6 and a water consumption by the boiler of 1750 lb., or 26.35 lb. per indicated horsepower-hour. He further makes the statement that a good noncondensing steam engine of this horsepower will consume not less than 32 lb. of water per indicated horsepower-hour. An addendum, not by Professor Vincent, states that 32 lb. for a noncondensing steam engine of 66 indicated horsepower is extremely low, but on inquiring why this statement was made we are informed by John T. Christie of the Christie Engine Co., that according to Gebhardt's Steam Power Plant Engineering, a 70-hp. engine under best conditions consumes 32 lb. of water per indicated horsepower-hour, and a simple noncondensing engine of 120 horsepower used 32 lb. Looking up these references it seems that the first engine was a 12 by 12, single valve, running at 300 r. p. m., and taking steam at 80 lb. pressure. The second engine was a Reeves single valve, steam at 114 lb. pressure. In neither case was it a Corliss or a 4 valve.

In his letter Mr. Christie says, "A careful reading of the enclosed booklet will demonstrate that the net result is that the steam from the point of cutoff expands the same as if it were in a perfect vacuum." Mr. Christie claims that the economics of the engine will be greatly increased when he gets higher pressures with superheated steam. He writes, "We have found that saturated steam cannot be used with economy above 120 lb., because the temperature of the compressed air with the higher pressures increases more rapidly than that of the steam. In other words, the incoming steam will cool the air. Steam must be introduced at the same or a higher temperature than the compressed air, hence, the necessity of using superheated steam at pressures above 120 lb." Further on he states, "We are preparing to put in a separately fired superheater, and will then be able to furnish full and complete data up to 150 lb. pressure."

No explanation is given why the single test is the only one that has been run, and there seems no good reason why as complete data as possible without the superheater should not have been obtained. In writing for information we asked for a complete log of the test but no such data has been furnished.

It appears from the present attitude that there is more interest in getting in a new superheater and possibly in using this as a reason for needing more capital than there is in getting as quickly as possible engineering data in regard to the possibilities of the air-steam method of operating. Tests can easily be made at lower pressures, if the engine does not seem efficient without superheated steam at the pressures above 120 lb., to determine steam consumption at quarter, half and full load and to determine the friction load of the engine, so that comparison may be made between this system of working and the use of steam in the ordinary engine; and also the mechanical efficiency of the machine, which may be low because of the complicated valve gear, could be found. The theory of the expansion of the steam in mixture with air, seems to offer a plausible method of increasing the possible thermal efficiency of the steam cycle. In such a case there is always the possibility of mechanical considerations coming in or of other losses more than offsetting the saving in the thermal efficiency, and it was the hope of Practical Engineer that definite information on these points would be forthcoming as soon as possible, but the promoters of the Christie engine seem now inclined to delay and to avoid the direct issue of a carefully conducted and thorough series of tests.

## WARNING!

**In Western Ohio, a swindler signing the name "J. Ryan" has been making impossible offers of Practical Engineer with free premiums. He is in no way connected with Practical Engineer and has simply stolen whatever money he has collected. Practical Engineer is sold only by agents who carry full credentials, give receipts on regular forms bearing the special heading, and at one price as advertised.**

**The publishers are anxious to get trace of Ryan and will reward liberally information that will lead to his arrest.**

**Will readers kindly call attention of all engineers to the following description and ask any who have had dealings with him to send details and evidence to this office at once?**

**Five feet 6 inches in height; weight, about 150 lbs.; eyes, blue; hair, light; mustache, sandy; age, about 35 yrs.**

# PRACTICAL ENGINEER

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## ANOTHER STEP FORWARD

In conformity with its policy of steady advancement, the publishers of Practical Engineer, realizing the need of added space to give all of the news and data which are of vital importance to its host of readers, have taken up the matter of how best to meet this need. After careful consideration of different methods, and talk and conference with readers and others most familiar with the field, increase in size of the monthly issue was discarded in favor of the semi-monthly issue.

The details will be found on another page, and we feel certain that our readers will appreciate the progressive and liberal policy which has adopted this change in their interest. We would call attention particularly to the opportunity offered to secure a 2 years' subscription at the present special rate of $1.50, if the order, new or renewal, is sent before Dec. 31, 1911. It is an opportunity that readers cannot afford to miss, and to which your friends will appreciate having their attention called.

## TAKING A CALL DOWN

Did you ever get one? Too embarrassing a question isn't it? But why be sensitive about it. Every man jack of us makes mistakes sometimes, and it's the business of the boss to take notice of them. If it is a mistake of judgment, he is not likely to go further than a caution to be careful; he has made that kind himself and knows that they are a necessary part of a man's education.

If it was plain carelessness and you knew better, he is likely to say things in no uncertain language; and he ought to; that's what he gets paid for, to get rid of the cost of carelessness.

Well, what do you do? If it was just bad judgment, do you state that fact and tell why you thought that you were doing right, and so give and get a chance for a helpful talk-it-over with the boss? Or do you shut up like a clam and let him feel that you were indifferent and deserve a good scolding?

And when you deserve the scolding and get it a good plenty, do you take it like a man, admit you were wrong, make up your mind that that's the last time and be thankful that you got another chance instead of the blue envelope? Or do you get a grouch, go sulky and make the boss feel that it is a mistake not to fire you on the spot?

Call downs were devised for the good of mankind. As David Harum says that "Fleas are good for a dog, because they keep him from worrying about being a dog," so a call down wards off an attack of swelled head, and prevents worry about the tardy coming of promotion and more wages. Also a properly administered and received call down points the way to overcoming faults and making progress.

And if you happen to be the boss, are your call downs given in the spirit of that last statement? If not, why not? Why are you boss?

### IN THE EMERGENCY

When it happens, what will it be and what will you do? One thing is certain, when it comes there will be mighty short time to plan, and all thinking which has been done beforehand will be extra helpful. Which is why the suggestion of a correspondent that readers send in an account of their emergencies for discussion is good and we trust will be followed by all who encounter an unusual happening in their own or other plants. The writer starts the ball rolling. Who's next?

## POWER PLANT BETTERMENT *

By H. H. Hunt†

THE coal question is one of the most important, and one of the most troublesome, which is encountered in power plant operation. The quality of coal must necessarily depend, to a certain extent, upon the location of the power plant as related to the sources of coal supply. It will be found profitable to have a careful investigation made of the possible sources from which coal may be secured at reasonable prices.

Full data should be gathered regarding the analysis of the various coals available and that coal selected which will meet local conditions with best results.

While not always practicable, it is none the less desirable to purchase coal on the analysis basis under carefully drawn specifications which provide for forfeiture and bonus according to whether the coal falls short of or exceeds the requirements of the contract. Under such a contract, an analysis of each shipment of coal is necessary. Where the annual consumption is comparatively small, it is not practicable to purchase coal on the analysis basis, in that event the best that can be done is to buy it of responsible dealers who handle the best coal to be had under the circumstances.

The accounting for coal purchased, while seemingly simple, proves in practice more or less troublesome, and frequent checks between station records, coal on hand and fuel accounts are necessary.

It will be found desirable to arrange proper scales for weighing in bulk the coal which comes into the yard, and if a contract for purchase can be so arranged as to make payments on basis of company's weights, one question of coal shortage will be removed. Bins should be provided which will enable the coal supply to be accurately measured at any time. Then the coal passing into the fire room must be carefully weighed and weights recorded. With these data at hand, and this system carefully followed, there is no excuse for coal shortage.

### Keeping Fit

PROPER and systematic maintenance is an important part of power plant betterment work. It is not sufficient to wait until something breaks before giving it attention, for the breakdown may occur at a time when the machine is needed to maintain continuous service, to say nothing of the excess cost of repairs over what would probably have been the case had the condition been anticipated and the break avoided.

Low cost of maintenance does not always indicate thorough or economical maintenance, for while the plant may be run for months on abnormally low maintenance costs, the time will come when the accumulation will require excessive expenditures, if not for new apparatus, certainly for the overhaul and repair of the old:

### Maintenance Schedule

IT is, therefore, desirable to prepare a proper maintenance schedule which shall be carefully and conscientiously followed by the operating force. Such a schedule will set forth definite dates for the inspection of all apparatus; the schedule to be arranged so that each and every part will receive periodic attention as often as is necessary to keep it in good operating condition.

The history of such systematic maintenance is of value to those in charge, as it will enable them to pursue the work with greater intelligence and expedition. A log book should, therefore, be used in connection with the maintenance schedules, and in this log book should be carefully recorded, in detail, the results of all inspections, repairs, adjustments, etc. By the aid of this maintenance log and a careful following of schedule, proper maintenance of every part of the plant will be assured and unexpected breakdowns practically avoided, giving the continuous service, which is so necessary to success.

### Why Betterment?

WHAT may be expected as the result of this power plant betterment work? First: Accurate knowledge of the maximum efficiency of which the particular plant under consideration is capable. Second: The securing of this efficiency through the efforts of a well trained efficient operating force. Third: Systematic and economical maintenance producing maximum life of apparatus and continuity of service. Fourth: In case of failure to continue to produce results, a knowledge of the reason why.

The continued operation of a power plant under the conditions established by successful betterment work, by which maximum economy in operation and maintenance are secured, calls for active and energetic work on the part of the operating force. In fact, from the manager of the company all along the line down to the coal passers in the power plant, every man must work to best advantage. After the novelty of the improved condition wears off, the operation of the plant becomes not only monotonous but exceedingly strenuous. It is so much easier to slip back a little than to maintain the required pace that frequent checking of the plant operation is necessary. The chief must give his personal attention to this matter.

In spite of all reasonable efforts, it is quite likely that the economy of the plant may gradually decrease because of a combination of little things which creep into the operation of the plant unnoticed. This has been noted in actual experience and has led to the belief that a periodical power plant examination by a competent expert is necessary. This will require less time than for the original examination, especially if both examinations are made by the same man, and should not, therefore, be very expensive.

It should not be inferred from what has just been said regarding the daily and periodical check that the economical operation of a power plant is impractical because of the detailed attention required on the part of the management and operating force. Not only has experience proved the contrary to be true, but results have clearly justified the trouble and expense. Power plant betterment work has come to stay.

*Abstract of paper read before the Congress of Technology.
†Stone & Webster Management Association, Boston.

# PRACTICAL ENGINEER WILL

**Two Issues a Month, Be-**
**Special Two Years'**
**Withdrawn**

PROGRESS AND EXPANSION in power plants are more rapid than ever before and the development of new machinery and installations demands more extensive treatment than the present size of Practical Engineer permits; therefore, it has become necessary to choose between increasing the already large number of reading pages in one issue a month, which would make it unwieldy, or issuing two numbers a month.

Careful consideration has been given to both alternatives, and the desires as well as the best interest of subscribers have pointed to the semi-monthly as the better solution of the problem.

Not only are two average size issues easier to handle in reading, but it is easier to find a desired article — easier to keep posted on what the paper contains and to read it thoroughly. The more frequent issue also gives opportunity for prompt replies to questions from readers, closer connection between their letters discussing power plant topics and more timely reports of current happenings.

The increasing number of readers and their candid recongnition of Practical Engineer as their authority and most practical help, bring increased demand for information on a greater variety of subjects, including management and economics, refrigeration, heating and ventilating, hydraulic work, and electrical appliances.

Because of the enlargements and improvements made necessary by this demand, and the corresponding advantages of a semi-monthly to subscribers, we are pleased to announce that beginning

# BECOME A SEMI-MONTHLY

**ginning January 1st, 1912.**
**Subscription Offers**
**On That Date.**

Volume XVI, No. 1, January, 1912, Practical Engineer will be published on the first and the fifteenth of every month.

The subscription price will remain $1.00 per year, therefore subscribers will receive twenty-four numbers at the former price of twelve.

To each present subscriber the semi-monthly will be sent to the end of his subscription period; and until Dec. 31, 1911, renewals may be made at the special two year's rate of $1.50; also new subscriptions sent before Dec. 31, 1911, will be taken at that rate. But on Jan. 1, 1912, the two year's rate will be withdrawn and the subscription price will be $1 for one year.

We can only promise that in all respects the semi-monthly will maintain the high standard of the monthly, and that full advantage will be taken of the added opportunity for helpfulness. The same policy, "The best for Practical Engineer readers," will be carried out, and every practical improvement which can be suggested will be added.

The only thought and purpose of the editorial staff is to have Practical Engineer of greatest and most practical help to the greatest number of engineers. Whatsoever will work to that end is always welcome. With this purpose the new departure has been decided upon and we trust that you, the members of the Practical Engineer family, will take fullest advantage of the increased possibilities of helpfulness.

TECHNICAL PUBLISHING CO.

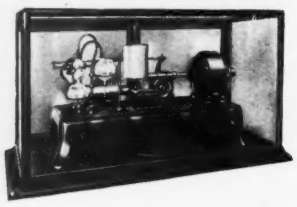
## COMMERCIAL GRAPHIC RECORDING METERS

(Continued from page 738.)

### THE EDDY AUTOMATIC SMOKE RECORDER

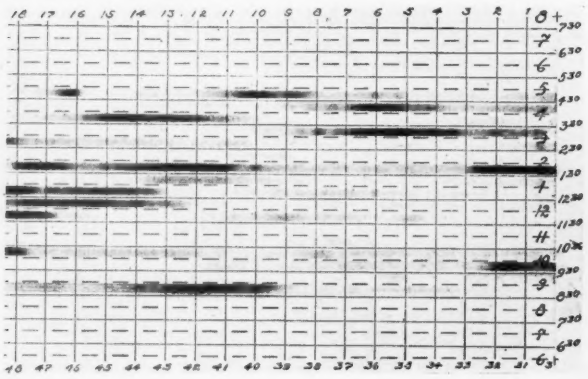
WITH the present agitation by city authorities against smoking power plant chimneys it seems almost essential that the fireman of the plant knows continually exactly what the color of the smoke is that issues from his stack. To guide him in this direction the Eddy automatic smoke recorder, manufactured by the Hamler-Eddy Smoke Recorder Co., has been produced.

The principle of this machine is to draw a record, upon a white sheet, which is the color of the smoke issuing from the stack. Its primary elements are a pump, a tube leading from the pump to the chimney and another tube with a small discharge orifice, leading



EDDY AUTOMATIC SMOKE RECORDER

from the pump to the neighborhood of a sheet of white paper. The pump draws the chimney gases through the first tube and forces them through the second in a fine stream against the paper. The coloring matter in the gases, whatever it may be, is driven into the pores of the paper and makes the record.



RECORD MADE BY EDDY SMOKE RECORDER

The gases on their way from the chimney to the pump are first passed through a condenser and across the surface of sulphuric acid in a closed vessel. This is for the purpose of removing the water vapor carried by the gases. The chart is cross ruled for hours and minutes.

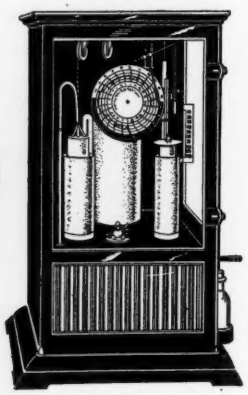
### THE TACHOGRAPH

THE continuous record of a machine comprising its time of running, starts and stops and speed variations, is often necessary. The Tachograph, manufactured by The Industrial Instrument Co. of Foxboro, Mass., is designed to meet all such conditions and to indicate on a dial the speed at any instant. The actuating mechanism for the indicator and for the recorder pen depends on centrifugal force derived from the revolving balls similar to the ordinary governor principle. The recorder drum is of aluminum and may be set to revolve once in 12 or 24 hr., a self-contained clock furnishing the motive power. Charts are furnished to read either in revolutions per minute, or feet or yards per minute.

### THE $CO_2$MBUSTION AND PRECISION DEAD BEAT RECORDERS

THE $CO_2$mbustion recorder, made by the Precision Instrument Co., of Detroit, Mich., gives a continuous, automatic record of the combustion. Imperfect combustion and leaky setting may thus be readily detected. It may be installed with a set of boilers as

THE TACHOGRAPH



THE $CO_2$MBUSTION RECORDER

well as with one. This recorder is made in several types but all are of the same size, 20 by 14 by 33 in. The frame is of cast-iron, painted dark, while the mechanism is of an ornamental finish. No glass vessels are used in its construction. The chemical agent

THE PRECISION DEAD-BEAT RECORDER

is caustic soda absorbing the carbon dioxide from the gas which is admitted regularly in equal quantities by automatic arrangement.

The Precision Dead Beat Recorder for steam, gas and liquids employs specially drawn Bourdon tubes for high pressures; for low ranges, diaphragms are used. In these diaphragms 2 strata of metal are used.

one of high elasticity and the other of high resistance to corrosion. These gages are ready for use when sent out. No oil seals are required in transmission pipes. This instrument is made in over 200 ranges by the Precision Instrument Co.

## THE VENTURI HOT WATER METER

THIS apparatus is a constant check on the amount of water fed to the boilers. The principle upon which the meter operates is as follows: When water flows through a pipe containing a contraction, the pressure at the throat of the contraction is less than at the inlet, due to the increased velocity. In a properly proportioned pipe, this loss of pressure is almost entirely regained at the point where the pipe has enlarged to the same diameter as the inlet. Therefore the same amount of water will be delivered through such a pipe (called the Venturi meter tube) as through a straight pipe of equal length and diameter.

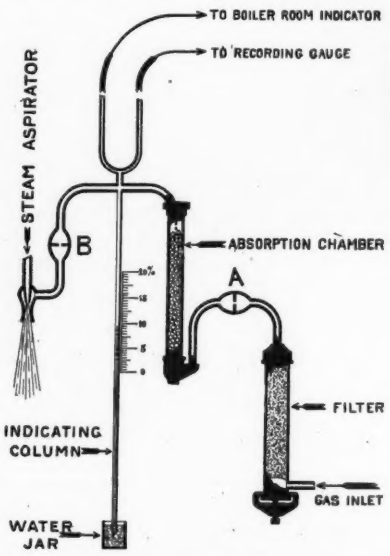


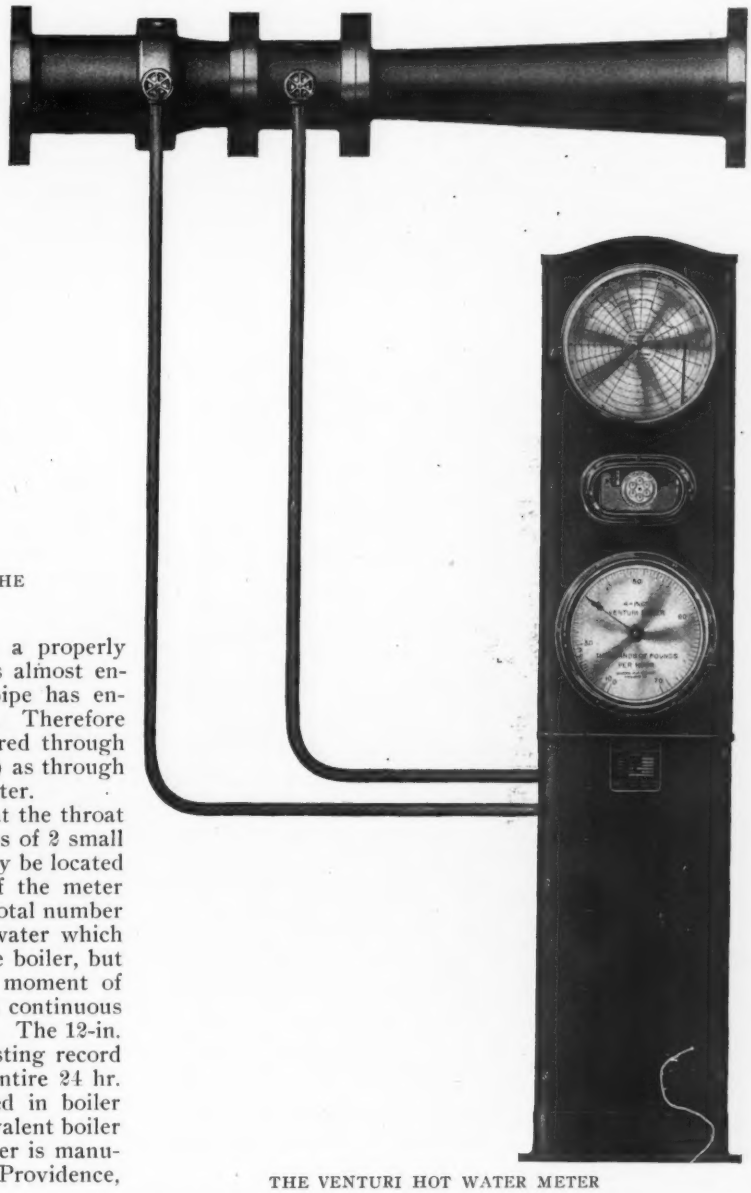

FIG. I. DIAGRAM SHOWING PRINCIPLE OF THE UEHLING WASTE RECORDER

The pressure at the full diameter and at the throat of the meter tube are transmitted by means of 2 small pressure pipes to the instrument, which may be located at any convenient point within 200 ft. of the meter tube. This instrument not only gives the total number of pounds, cubic feet, or other units, of water which have passed through the meter tube to the boiler, but it also indicates the rate of flow at the moment of observation on the lower dial and makes a continuous record of the rate of flow on the upper dial. The 12-in. charts from the upper dial form an interesting record of the load on the plant throughout the entire 24 hr. The indicator dial is very often graduated in boiler horsepower, thus showing at once the equivalent boiler horsepower for the rate of flow. This meter is manufactured by the Builders' Iron Foundry, Providence, R. I.

## THE UEHLING WASTE RECORDER

THE Waste Recorder manufactured by Uehling Instrument Co., Passaic, N. J., consists of a carbon dioxide and temperature recorder combined in one apparatus. Its records show the waste of heat up the chimney due to temperature as well as that due to excessive air in the flue gas. Its operation is based on the law of flow of gas through 2 small apertures; Fig. 1 illustrates the essential elements.

By means of an aspirator a continuous flow of gas is drawn through the apertures A and B. The gas enters through a filter which frees it from solid matter before entering aperture A, an absorption chamber located between the 2 apertures eliminates the carbon dioxide and the balance of the gas passes through aperture B to the aspirator. Now if the suction created by the aspirator is kept constant the partial vacuum between the 2 apertures will vary with the per cent of gas absorbed and this variation in vacuum is indicated by one or more manometer tubes and recorded by a properly designed and calibrated recording gage. Since the flow of gas is continuous, and the carbon dioxide is continually absorbed as the gas flows from aperture A to aperture B, both indication and record must also be continuous and in accordance with the carbon dioxide contents of the gas.



THE VENTURI HOT WATER METER

The temperature of the gas is measured on the same principle; aperture A is located in a tube which is inserted in the up-take or chimney, the same aspirator induces a continuous flow of air, which is purified from dust by a filter and enters aperture A at the temperature surrounding the tube, and passes through aperture B at a constant temperature of 212 deg. (aperture B of the pyrometer and also apertures A and B of the carbon dioxide element being surrounded by the exhaust steam of the aspirator) the reduction of volume due to the difference of temperature existing respectively at A and B, is indicated in degrees of heat in the same manner as the per cent of carbon dioxide.

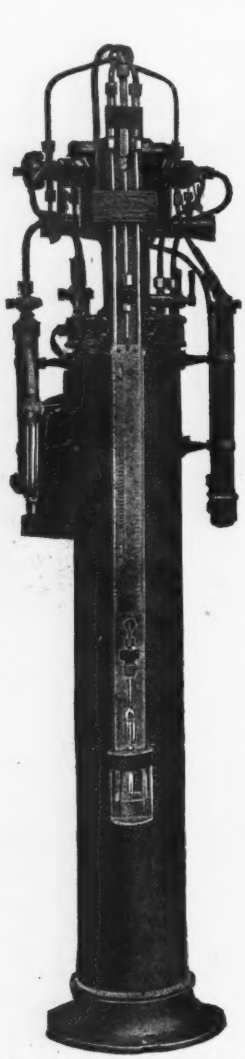
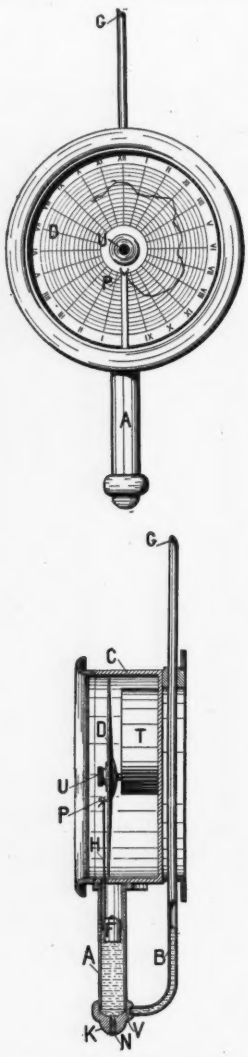


FIG. 2. UEHLING WASTE RECORDER




FRONT AND SIDE SECTION OF UEHLING VACUUM RECORDING GAGE

Figure 2 shows the waste recorder which is a combined carbon dioxide and temperature recorder. It is substantially built, all pipe connections are made of drawn copper tubing, there is no delicate mechanism.

The operating principle permits placing the main instrument some distance away from the dirty surroundings of the boiler, as in the engine room or other suitable place, the recorder in the engineer's office, and carbon dioxide indicator on the boiler front. Both carbon dioxide and the temperature are shown on the front of the main instrument. To attain and maintain efficient firing the fireman must know what he is doing and the engineer or superintendent must know what has been done. The waste recorder was designed to meet this requirement.

## THE UEHLING VACUUM RECORDING GAGE

THIS instrument, manufactured by the Uehling Instrument Co., consists essentially of a steel U-tube, one leg of which is of sufficient size to contain a float and is fastened to a case containing a clock work which rotates a recording disk in the usual way.

The smaller leg, made of drawn steel tubing, extends above the top of the case, to which it is fastened and connects with the source of vacuum to be recorded. The pen is actuated by a steel float resting on the mercury column in the large leg. The cross sectional areas of the 2 legs are so chosen that the movement of the pen covers the chart when the vacuum has caused the mercury to rise to the maximum height in the steel tube. This tube may be of uniform diameter, in which case the chart has uniform divisions from 0 to 30 in.; or it may be very small for a distance and then enlarged. By this means the important portion of the record is widened out, making an open scale, thus insuring closer and more accurate reading.

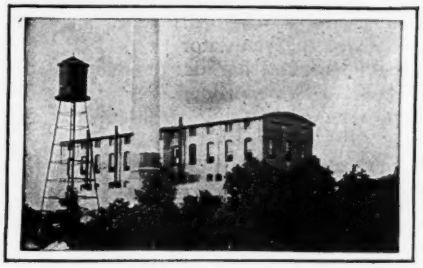
## WHY FIRE LOSSES ARE LIGHT

THE most convincing argument against the careless construction of buildings in this country as regards protection against fire, and the national carelessness in operation which is responsible for so large a proportion of the fire waste, is that fire losses in European cities are about one-tenth what they are in cities of smaller size in this country. A good illustration of this is furnished by the report furnished the State department by Consul Joseph L. Brittain of Prague, Bohemia. He says that in the last 3 years the loss from fire has been less than $20,300 annually and that it has been 15 yr. since a life was lost by fire.

In the ordinary American city of half a million population, the fire loss would average at least $1,000,000 a year, while the deaths from fire will be numerous. Prague's immunity from loss is chiefly due to the superior construction required by law and the careful habits of the people, and the responsibility that fire damage entails upon the owner of property. Most of the buildings are built of brick or stone with tiled roofs, the hallways are usually of concrete and the stairs of stone, and the kitchen floors are built of concrete with tile wainscoting.

The erection of hazardous buildings is not permitted and when a man is so unfortunate as to have a fire, he is looked on as an offender in the eyes of the law and is held responsible for any damage that may be done to adjoining property. The per capita fire loss of $3 in American cities as compared with such a record as this shows the enormous price this country is paying, both in life and property, for its hazardous construction and general carelessness.

THE SPECIALIST and the one-piece man differ in that the specialist takes into account all conditions and things related to his line, while the one-piece man considers only a single detail.



# Power Apparatus

## In Shop and Market

New Ideas in Making, Buying and Selling

## SAFEGUARDING LIFE AND PROPERTY

DEATHS, accidents and many thousands of dollars of damaged and ruined material of various kinds caused by escaping steam and water from broken glasses in water gages is a happening in engine rooms too frequently to be disregarded.

But the Gaco self-closing safety water gage, although it cannot be closed by outward means, closes instantly when a glass breaks, thus preventing false water level.

This gage protects boilers whether attended or unattended. It prevents scalding by steam and boiling water while the operator is closing gage.

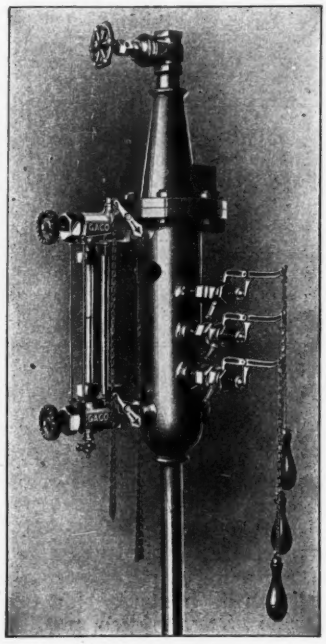


FIG. I. THE GACO APPLIANCES ON A WATER COLUMN

Mechanism of the Gaco, Fig. 2, is simple. The side bar operates so as to throw the check upwards, allowing a reamer to pass through for cleaning after removing the stem. The port is sufficiently large to permit removal of seat.

Points of merit in this gage are substantial construction, few parts, stuffing nuts of sufficient size to admit large gaskets; large port, uniform through the entire gage, prevents clogging or corrosion; in case a reamer is used, the construction of gage allows passage of reamer into water column or boiler while in position by simply removing front stem; free swinging disc suspended from above, which makes it impossible for scale or sediment to lodge on it, as would be the case if hinged on the bottom; seat is easily removed without damage by unscrewing and large opening admits of use of tools.

Study of the illustrations will show that the gage has positive action, and must close whenever the glass breaks. Under all circumstances it has been found to work satisfactorily.

The Gaco gage cock is one that can be taken down under a full head of pressure and repaired in a few minutes by replacing the protected disc gasket.

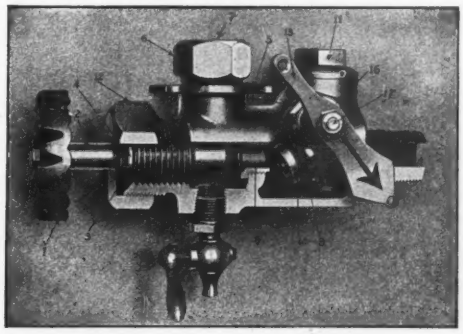


FIG. 2. SECTION OF THE GACO SELF-CLOSING SAFETY WATER GAGE FITTING

The Gaco has a double removable seat, so that when taking down, the inner seat closes, keeping the steam and water in the boiler while repairing gaskets. No regrinding is required.

The spring and stuffing box are so arranged as to keep the seat positively closed, with packing in place, and prevent leakage around the outer stem.

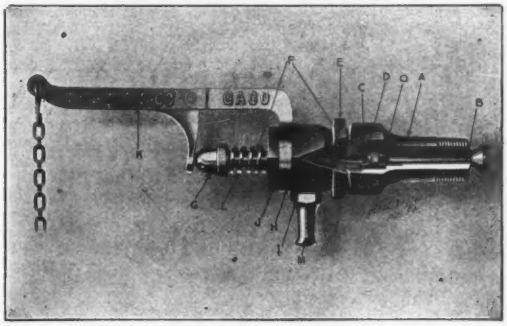


FIG. 3. SECTION OF GACO TAKE DOWN GAGE COCK

It has an adjustable lever to enable attendant to operate in any angle desired, from the floor.

As the cock is heavy and large, it cannot be twisted out of shape or broken off, as often happens with light construction.

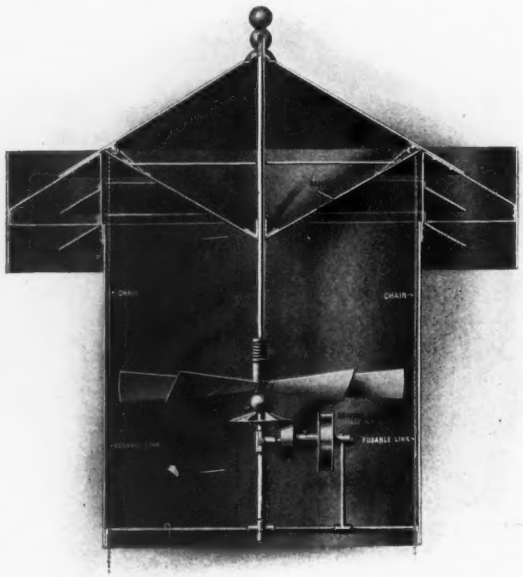
When installing the water gage, after connections are made to water column or boiler and glass is in

place, attach chain as shown in the cut. Turn the wheel to the left until valve stem is opened wide. Pull down the chain attached to small end of side levers, opening the clapper disc and allowing the glass to fill. After filling the glass, pull down the chain attached to arrow end of side levers as far as it will go, leaving arrow ends always down as shown in cut.

To blow down the gage glass, pull down and hold the chain attached to small end of side levers, thereby holding clapper discs open. While holding down the chain, open pet cock or drain pipe valve, allowing passage of steam and water from the gage glass. After closing pet cock or drain pipe valve, pull down the chain attached to arrow ends of side levers, so as to leave the arrows pointing down.

## THE BURT FAN VENTILATOR

IN many buildings, such as blacksmith shops, foundries, rubber factories and boiler rooms, fumes, odors and heated gases must be removed in order to insure safety and comfort of operators. It is desirable to remove these quickly and at slight expense, and the Burt fan ventilator herewith illustrated is designed for the most difficult conditions to take the place of the blower



SECTION OF BURT FAN VENTILATOR

system for most places where quick removal of air or gases is necessary. For ordinary conditions the regular ventilator will in most cases be sufficient.

In the fan ventilator the construction is such that the fan operates at 250 to 300 r. p. m., giving an air removal for a certain length of time some ten times that of the average stationary ventilator.

As will be seen from the sectional cut, the fan is placed in the body of the ventilator and is driven either by a pulley or by a motor direct connected to the fan. In either case the fan can be arranged so that by reversing the direction cold air may be forced into the building for cooling.

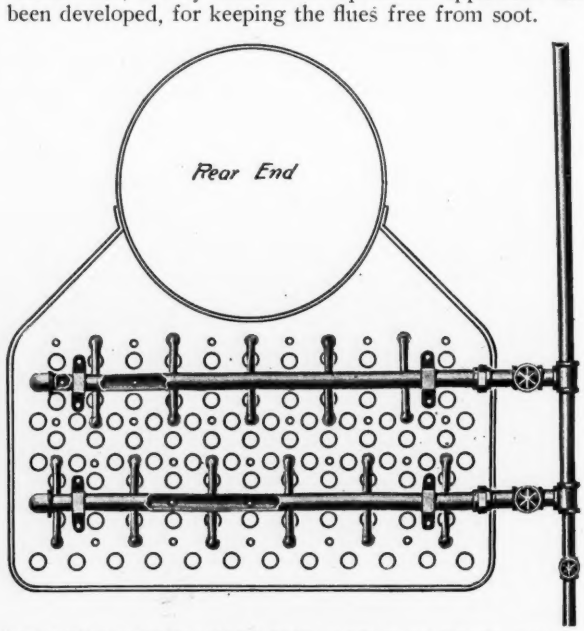
The ventilator is manufactured in 2 sizes, 36 and 48 in., the power required for each fan being ¼ hp. In order to shut off the draft in case of fire, the damper is arranged with fusible links in the chains, so that with dangerous heating these links will melt, permitting the damper to drop and close the ventilator.

The services of the engineering department of the Burt Mfg. Co., 204 Main St., Akron, Ohio, are available to those who have ventilating problems to be solved.

## A DIAMOND SOOT BLOWER ATTACHED TO HEINE BOILERS

AN extraordinary design of soot blower is that manufactured by the Diamond Power Specialty Co., of Detroit, Mich., for water-tube boilers such as the Heine, where there are no side cleaning doors.

In this instance the hollow stay bolts have been utilized and, by means of cross arms from the main horizontal arm, a very efficient and practical apparatus has been developed, for keeping the flues free from soot.




ATTACHMENT OF DIAMOND SOOT BLOWER TO HEINE BOILER

These cross arms run directly through the hollow stay bolts into the tube chamber, ending in a jet, and are sufficient in number to blow every portion of the boiler with equal thoroughness.

There are 3 units to this apparatus—2 in the rear and one in the front, this being sufficient to reach every portion of the boiler, as described in detail in a descriptive folder to be obtained by dropping a line to the Diamond Power Specialty Co., Detroit, Mich.

## GRAPHITE BUSHINGS AND BEARINGS

IN THE September issue the use of graphite as a lubricant both by itself and combined with grease or oil was discussed, and its value in cutting down the lubrication required, and in lowering the friction in machinery was fully demonstrated.

A form in which it may be used is graphited bushings or bearings, which are made of bronze with grooves cut or holes bored, and the spaces thus secured are filled with the graphite pressed into place. Such bushings and bearings are manufactured by the Graphite Lubricating Co., of Bound Brook, N. J., and

they state that it makes little difference with the success of the bearings how high or low the velocity, or how heavy the pressure. An advantage of these bearings is that they can be run without oil or grease, although the use of a lubricant is desirable.

Examples of uses to which such bearings are daily put, are the blocks through which the cables pass for heavy logging work, turret bearings for battleships, heavy bearings for steam engines, high speed bearings for steam turbines, bearings for gas engines, trolley wheel bushings, bushings for sheave wheels, and thrust bearings. These bushings have the ability to stand wear for a long time without attention, and with little or no lubrication, thus making them suitable for places where attention is difficult as well as for other trying service.

## FRANCE METALLIC GAS ENGINE PACKING

A SOURCE of great annoyance and expense in large gas engines has been the packing for the rods. The France Packing Co., which for the past 15 years has been successfully manufacturing the France Steam packing, has been making a metal gas engine packing for 5 years, and it has withstood the hardest service.

The case and rings are made of cast iron. The rings are the same construction as the France Steam Ring, except that, as shown in the cuts, the groove for the spring is placed in the face of the ring, which protects the spring from flame, dirt and grit, incident to gas engine service.

Where the engine builder makes provision for oiling the packing through a hole in the stuffing box, the Inside Split Case type, shown in Fig. 1, is used. Where no provision is made for oiling the packing through a hole in the stuffing box, the Inside Split Case type with external flange, as shown in Fig. 2, is used. Here oil enters the packing through an oil hole in the packing case.

When put on a rod that is true—not scored or pitted—this packing is guaranteed to be satisfactory or no pay expected. It is being used in the largest gas engine power plants, and is made by the France Packing Co., Tacony, Philadelphia, Pa.

## PECULIARITIES OF WHITE METAL ALLOYS

HIGH-GRADE commercial alloys have been developed gradually, and the secrets which impart to such metals their special values are carefully guarded. It is a mistaken idea that maximum results can be obtained, merely by melting down and mixing together various proportions of metals.

The best grade of solder is composed of equal parts of tin and lead. The fusing point of tin is 446 deg. F., and of lead 619 deg. F., and the mean arithmetic fusing point of this mixture is 532 deg. F., but as a matter of fact solder fuses at 370 deg., which is much under even the lowest constituent of the mass. Despite the general knowledge of this fact, babbitts are frequently found closely approximating the solder formula, and although such metals will stand the ordinary physical tests for hardness, toughness, peening, etc., they are highly susceptible to frictional heat, and therefore are liable to soften and squash out of the box at comparatively low temperature.

Spelter alloy (white brass) also presents some peculiar features. When in a cold state it gives every indi-

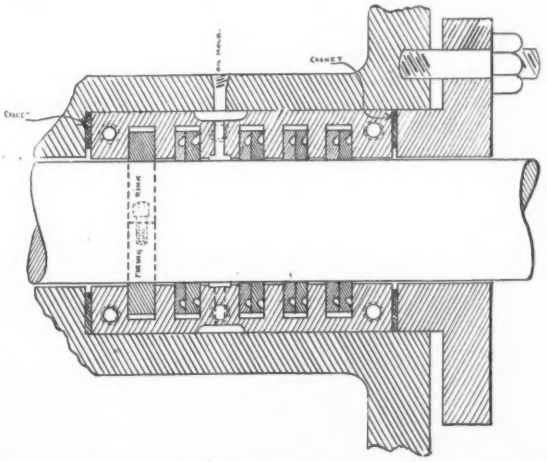


FIG. 1. INSIDE SPLIT CASE TYPE OF FRANCE GAS ENGINE ROD PACKING

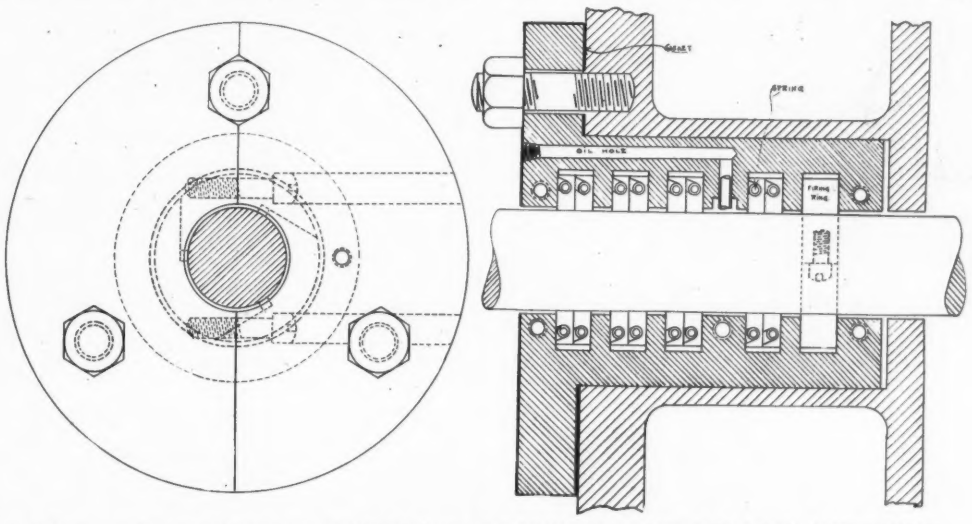



FIG. 2. TYPE OF FRANCE GAS ENGINE ROD PACKING TO OIL THROUGH PACKING CASE FLANGE

cation of being an ideal bearing metal, being hard, tough, ductile, and peens perfectly; but woe betide the bearing lined with this mixture when the temperature reaches 300 deg. F. When it does let down there are no halfway measures about it, as it loses all atomic cohesion, and it can be pulverized with a lead pencil. This peculiar quality of white brass is generally known, and its use is usually confined to bearings where service is intermittent, and not likely to create much frictional heat. It has also had a certain vogue on steamships where the temperature can be kept down with streams of water running over the bearings.

Perhaps the most remarkable of all the white metal alloys is the mixture used for fusible plugs. It is composed of bismuth, melting point 507 deg; cadmium, 610 deg. F., and tin, 446 deg. F., and the mean arithmetic fusing point is higher even than solder. But, if this composition were moulded into, say the form of a spoon, it would give evidence in weight, strength and appearance of being a useful table implement, and yet it would melt in hot water.

Knowledge of many such facts, and then more, are requisite as a preliminary to equip a person to produce even an ordinary grade of babbitt metal that is properly made and evenly balanced. A person must at least know what metals have affinity, and those that are antagonistic, and to what extent metals influence each other and will properly alloy. When it comes to the production of a high-grade antifriction metal such as Magnolia, it requires special fine points carried out with the precision of a drug prescription by specially trained and skilled workmen, and the mere knowledge of the formula would in itself be of little use in imparting the special characteristics and value of that product.

"SMALL EFFORTS are the seeds for great successes."

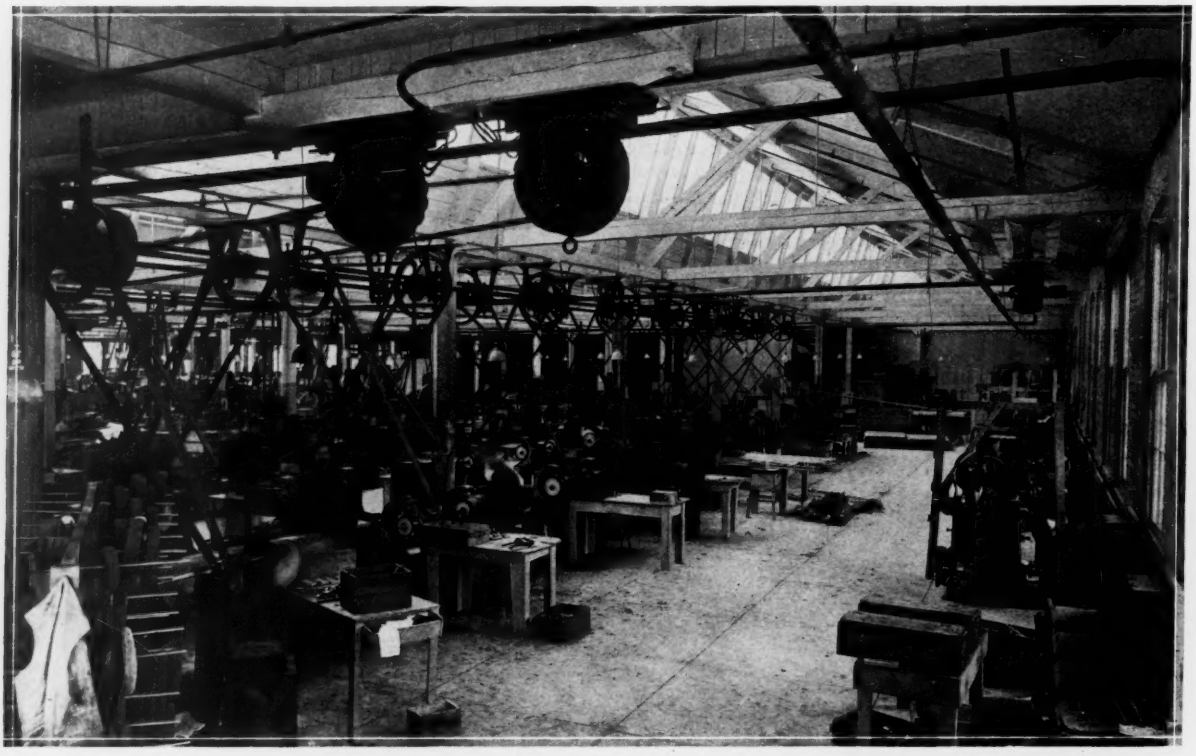
# MOTOR DRIVE IN NEW FACTORY OF TROY CARRIAGE SUNSHADE

STARTING in the manufacture of advertising sunshades for vehicles this firm added a department for the manufacture of glass windshields for automobiles, which is by far the larger part of its business. The company had recently erected and now occupies a fine modern factory building devoted exclusively to the manufacture of windshields.

This building is constructed of gray brick, is 200 ft. square, with factory occupying the ground floor, while a second story 200 by only 60 ft. is occupied by the office and show room.

As the management wished to improve operating conditions and reduce costs it substituted electric motors for the old engine, shafting and belts, the motor installation consisting of 147½ hp. in Westinghouse type CCL motors.

The greater part of the power used in this factory is required for the buffing and polishing department. There are in use 16 double polishing lathes driven in 2 groups of 8 each by 2 15-hp. motors. A 5-wheel automatic buffing machine for the buffiing of brass tubing is driven by an individual motor, the exhauster system for this department being equipped with a 60-in. Garden City exhauster belted to 30-hp. motor.



DRIVING MOTORS AT TROY CARRIAGE SUNSHADE CO.'S PLANT

A 15-hp. motor drives the machine shop and 2 10-hp. and one 7½-hp. motors are used in the wood-working department.

There is also a 25-hp. motor used for driving a direct-current generator for lighting and furnishing power to a number of small direct-current motors.

The power for the factory is furnished by the Troy Electrical Works, the local municipal lighting plant.

## OFFICERS OF N. E. A.

HEREWITH is shown the group picture of new officers of the National Exhibitors Association, which came to hand too late for publication with the report of the convention. Reading from left to right they are as follows: Front row: H. A. Pastre, of the Elliott Co., Pittsburgh, executive committee; Homer Whelpley, of Strong, Carlisle & Hammond Co., Cleveland, secretary; M. B. Skinner, of James McCrea & Co., Chicago, vice president; H. H. Ashton, of the Ashton Valve Co., Boston, president; Wm. P. Johnson, of the Under-Feed Stoker Co of America, treasurer; L. B. Mann, of Fairbanks Co., New York, executive committee. Rear row: Wm. D. Purcell, Home Rubber Co., Trenton, N. J., past president; J. W. Peterson, of the Richardson-Phenix Co., New York, executive committee; F. E. Sly, Allis-Chalmers Co., Milwaukee, Wis., executive committee; Harry Raymond, of A. W. Chesterton Co., Boston, executive committee.

## J. C. JURGENSEN

THE subject of this sketch, Jess Christian Jurgensen, was born at Grenaa, Denmark, February 16, 1871. He attended school at Grenaa until 14 years of age and then worked as an apprentice for his uncle who was an instrument and tool maker. His apprenticeship lasted 5 years and 3 months. After leaving his uncle's employ, he worked as a journeyman machinist in Germany. During the time he served as an apprentice, and while he was in Germany, he attended evening schools, taking up technical courses. After completing his work in Germany, he returned to Denmark, and for one year he worked in his uncle's shop as a journeyman machinist.

In the spring of 1893 he came to America, and landed in New York. From New York he went to Bridgeport, Conn., and entered the employ of Waddel & Entz as a machinist on electrical work. This firm was then completing the first generators for the Third Avenue Railroad Power House in New York. At the end of 3 months, business became so slack that this firm had to put all the men on half time. Mr. Jurgensen concluded that he had better seek other employment and worked his way, via Ocean Steamship Company, to Savannah, Ga., and from there to Florida.

While in Florida he turned his hand to anything to earn a living and worked as fisherman, hunter, cook, and railroad hand; he finally secured a place as electrician in a large hotel on the Indian River where he served one season under George Z. Johns.

In the spring of 1895 he came to New York again and shipped under Chief Engineer Johns, on the yacht, Reva, owned by Pierre Lorillard. Owing to illness he gave up this position after having served one and one-half years. When he had gained his health again, he secured a position as night electrician in the old Holland House under the Chief Engineer, Mr. Pinder. Here he served one year.

He next entered employ at the Bulkenhayn adjoining the Hotel Savoy as assistant engineer under J. G. Ould who was then the superintendent. Then he worked as a machinist for Seabury Marine Engine Works at Nyack, N. Y., and from there he went to the Catholic Club, N. Y., and worked as an assistant engineer. He next served as an assistant engineer in

RECENTLY ELECTED OFFICERS OF THE NATIONAL EXHIBITORS' ASSOCIATION

the Mail and Express Building, N. Y., under Chas. Olsen, chief engineer, and from there he went to the Polhemus Memorial Clinic Building, Brooklyn, N. Y., and worked as 1st assistant engineer under J. G. Ould.

He filled this position for 3 years when he was appointed by the faculty of Cornell Medical College, 23rd Street, New York City, as chief engineer. While holding this position he first saw the need of systematic training of engine room attendants, and started the system which has since become embodied in the objects of The Institute of Operating Engineers. It was while he was in the Cornell Medical College that he attracted the notice of J. J. Astor's secretary and R. M. Haan, who were then contemplating building the St. Regis Hotel. After a conference, the outcome was that Mr. Jurgensen was engaged as chief engineer to consult on the construction of this plant when it was put in. He had full charge of the operation of this plant for several years after it was installed.

In this place he inaugurated the system of apprenticeship training in the engine room, issuing certificates of merit to the men under him. His methods

J. C. JURGENSEN

here attracted the attention of the faculty of Columbia University who were desirous of starting a course of Plant Management under the head of Industrial Arts, and in the fall of 1909 Mr. Jurgensen outlined the course and spent the winter instructing and supervising it until his manifold duties made it impossible for him to follow it up and he was compelled to give up the work in this direction. But he is still retained by Columbia University in an advisory capacity in connection with this work.

While connected with the St. Regis Hotel, he also attracted the attention of the large mercantile house in Brooklyn, N. Y., Abraham & Straus. Here he entered the field of industrial engineering and for 2 years he had entire charge of the reorganizing of the working force in this store which has over 5000 employees. His work here attracted the attention of the owners of the United Piece Dye Works, Lodi, N. J., and for the past year he has been at this place reorganizing the complete working force of this immense plant.

His whole time is now taken up with industrial engineering and his services are in constant demand by other concerns. Mr. Jurgensen is also managing director of a large metallic casket company in this country where he is installing systematic methods of manufacture in their plants. Mr. Jurgensen is a member of the A. S. M. E., New York, No. 44, N. A. S. E. and has served as Chairman of the Executive Committee of The Institute of Operating Engineers, of which he was the originator and founder, since its inception.

# NEWS NOTES

THE EDUCATIONAL COMMITTEE of the Institute of Operating Engineers is now working on lesson papers to be used in the various courses of the Institute. Arrangements have recently been perfected in Chicago with the Armour and Lewis Institutes, and with public schools whereby special classes for Institute members will be conducted on operating engineering subjects, also in the city of New York public schools, the evening high schools, the Y. M. C. A., Modern Science Club, Pratt Institute, New York Trade School, Cooper Union, Brooklyn Polytechnic Institute and Columbia University. At Buffalo Y. M. C. A., a course will be given for Institute members. In Boston, Franklin Union and Wentworth Institute will have evening classes. In Newark, N. J., are extension classes at the Central Y. M. C. A. by the Columbia University instructors and in several other cities there are courses arranged on the half time basis for those just entering the profession.

GENERAL OFFICES of the American District Steam Co. have been removed from Lockport, N. Y., to the new works at North Tonawanda, N. Y., and all friends are invited to visit the company in its new home.

POWER PLANT ENGINEERS are interested in materials inasmuch as on proper testing depends the securing of the right materials for boiler and engine construction. The meeting of the International Association for Testing Materials, which is to be held in New York City beginning September 6, 1912, is, therefore, of importance to the field. Plans are now under way for this meeting, the work being in charge of H. F. J. Porter, secretary of the committee, 1 Madison Ave., New York City, from whom full particulars may be obtained. In general the work of the congress will consist of the reading of papers on the standard method of testing, reports of committees and special addresses. Papers for the meeting are not to be over 2500 words in length, with illustrations which can be reduced to 4¼ by 7-in. and still be clear, each paper to be accompanied by an abstract of 50 to 100 words attached to the paper. Such papers should be sent to F. E. Schmitt, 220 Broadway, New York City, before January 1, 1912.

THE BROWN HOISTING MACHINERY CO., of Cleveland, announces the opening of its San Francisco office, Monadnock Building, with Mr. J. P. Case as manager.

THE INTERURBAN LINE from Charlotte, N. C., to Greenwood, S. C., is progressing and cars will soon be in operation from Charlotte to Gastonia, a distance of about 25 miles, which will be completed in a few months. A number of passenger and freight cars have already arrived. Passenger cars are equipped with 4 1500-volt d. c. motors.

Charlotte being the headquarters for the interurban line, preparation is being made for a large and handsome depot on Mint St. Also work is being done on the big car shops.

The sub-station for the line which is ready for service, consists of 2 1500-volt 500-kw. generator sets. There will be several similar stations along the line at a distance of 30 or 40 miles apart.

THE ST. LOUIS Steam Engineers Club has voted to build a club house for social purposes. Officers recently elected are: President, F. C. Laufketter; vice president, H. C. Tulley; recording secretary, Lee Brannon; financial secretary, A. H. Herron; treasurer, O. P. Thompson.

THE VILTER MFG. CO., with offices at 972 Clinton St., Milwaukee, Wis., has lately acquired an extensive piece of real estate opposite its present plant, for the purpose of increasing and improving its facilities. Part of the new property will be immediately utilized for the

purpose of erecting thereon a pipe shop 270 ft. long and 120 ft. in width equipped with the latest improved appliances for the machining and handling, as well as storing of pipe used in connection with the refrigerating and ice-making plants built by this company. The new shops of this concern will also be served by a spur from the Chicago and Northwestern Railway Co. This new acquisition gives The Vilter Mfg. Co. considerable additional space covering more than 3 acres.

THE NATIONAL GAS & GASOLINE Engine Trades Association will hold its winter meeting at the Hotel Hollenden, Cleveland, Ohio, December 5 to 8. The forenoons will be devoted to inspection of exhibits, space being available for exhibitors at no cost to members and a charge of $10 for space to those not members. Application for space should be made to Albert Stritmatter, 224 East Seventh Ave., Cincinnati. Afternoons will be devoted to the discussion of technical papers and evenings will be allotted to the entertainment committee.

THOMAS H. PLATT has entered the New York City Sales Department of Dearborn Drug & Chemical Works, with headquarters at 229 Broadway, where he will be pleased to meet his friends in the engineering field.

THE BROWN HOISTING MACHINERY Co., of Cleveland, announces the opening of its Chicago office in the Commercial National Bank Building, with Mr. A. M. Merryweather as manager.

F. X. CLEARY has resigned his position as advertising manager for the Western Electric Co., to engage in special advertising and sales promotion service. Mr. Cleary's long service as salesman, sales manager, and advertising manager has given him a wide experience and acquaintanceship in the electrical field, which will continue to be his line of future effort.

P. L. Thomson, formerly manager of the Western Electric Co.'s Pittsburgh house, has been appointed advertising manager.

## BOOKS AND CATALOGS

LAMPS AND SHADES IN METAL AND ART GLASS, by John D. Adams, Chicago, 1911, 114 pages, 5 by 7 in. Cloth binding; price 50c.

The book contains complete instructions for making a variety of beautiful lamps and shades in metal and art glass, giving pleasing decorative effects. The designs include drop lights, reading lamps, dining-room domes, mission chandeliers, desk lights and library lamps, in built up shades, standard shades and etched shades. It will be found a useful book to the amateur workman interested in such construction.

ELECTRO PLATING, by Henry C. Reetz, Chicago, 1911, 100 pages, 5 by 7 in. Cloth binding; price 25c.

This book describes the electrical and shop equipment necessary for doing plating, gives instructions for cleaning goods, for plating with copper, silver or gold and brief business suggestions in regard to such work. The different processes are made plain by clear illustrations, and the directions are simple and easily followed.

MOTION STUDY, by Frank B. Gilbreth, New York, 1911, 116 pages, 5 by 8 in. In cloth binding, price $2 net.

The book describes the necessity for motion study in seeking to simplify methods of doing work. It explains how such motion study is to be taken up, analyzes the factors which enter into such study and shows the methods used in Mr. Gilbreth's own work in making the operations of brick laying easier for the men in his organization. It is an interesting study and shows quite clearly to one who is attentive the kind of operations that can be handled to advantage by motion study and scientific management. It illustrates clearly also the gain that can be made in almost any line of human endeavor by scientfiic study of the principles lying back of the work and arranging the method of working so as to be in harmony with natural law rather than in opposition to it.

MACHINE SHOP PRACTICE, by Wm. J. Kaup, New York, 1911, 227 pages, 5 by 8 in. Cloth binding; $1.25 net.

Mr. Kaup has had long experience in the teaching of shop methods according to the best of modern practice to students and workmen in the shop, and he is here putting into book form what he has learned in a long shop experience and a long teaching experience. His object as he himself states, is "a sincere desire only to help the other fellow," and the book rings true with this thought at all points. An outline of chapter headings best shows the work covered; these are, vise work, filing, scraping, hand tools, material for construction, drill presses, planers and shapers, lathe practice, cutting tools, boring mills, milling machines, measuring instruments, gearing, grinding, tool steel, tool making and shop systems. Illustrations are to the point, showing in great detail all the operations that are described so that it is possible to grasp almost from the illustrations alone the thoughts of the author.

Another notable feature is the series of questions at the end of each chapter, bringing out the important points which have been covered in the text, so that the book is useful alike to shop worker who wishes to study by himself and to the teacher in the class-room. Altogether, it is the kind of a book which can be heartily recommended to the younger man in the shop ranks and will be found useful by everyone who has occasion to do shop work in any metal.

STEAM TURBINES, by Jos. W. Roe, New York, 1911, 143 pages, 6 by 9 in. Cloth binding; price $2 net.

This is a book on a general design of turbines without going into refined treatment of the more difficult problems, and takes up also the principles of action of this machine. While the mathematics involved are not difficult, they demand, nevertheless, a knowledge of simple calculus of algebra and trigonometry, since all these enter into the question of flow of steam, reversal of direction of the steam jet, angle of the nozzle and other dimensions. It is intended for the designing engineer and the advanced engineering student rather than the operative man. For its purpose it is excellent, and there is much of it that can be read with profit by anyone who is interested in the method of action and the efficient field of operation of the turbine.

THOSE IN NEED of enclosed cartridge fuses will find a folder sent out by the A. F. Daum Co., of Pittsburgh, describing the Daum Refillable Cartridge Fuse Shells, an interesting piece of literature.

THE GENERAL ELECTRIC CO. has recently issued Bulletin 4857, which thoroughly describes its switchboard and high tension relays. Among these relays are those for circuit-opening, time-limit relays, inverse time-limit, definite time-limit, low voltage, no-voltage and overload, reverse current, reverse phase, etc. Each type of relay is illustrated and described, and the publication contains general notes on the use of relays, including a diagram of modern power house wiring and buses, and the location of relays.

BULLETIN 4859, recently issued by the General Electric Co., describes its line of synchronous condensers especially adapted for floating on the line for improving the power factor. These condensers have

been designed to meet the demand for a comparatively inexpensive high speed machine of this nature.

BULLETIN 4876, issued by the General Electric Co., on small plant direct-current switchboards, illustrates and describes that company's 76-in. direct-current panels designed for general use in small central stations and isolated plants. A choice of protective equipment is given to meet different requirements in regard to price.

FROM THE ENGINEERING DEPARTMENT of the National Electric Lamp Association, comes bulletins 16 and 17, the first on the Mazda Incandescent lamp for street lighting, and the second on economical operation of incandescent lamps, treated from the standpoints of both consumer and central station.

A NEW KIND of recording instrument put out by the Bristol Co., of Waterbury, Conn., is the water level gage described in bulletin 142.

BALL BEARING HANGERS, made by the Hess-Bright Mfg. Co., of Philadelphia, are great savers of friction loss. Their construction, application in different plants, and dimension tables showing space required, are all given in the catalog.

FROM THE FORT WAYNE Electric Works, of Fort Wayne, Ind., come bulletins as follows: 1130 describes the type K direct-current motor, made by the Northern Electric Co., of Madison, Wis.; bulletin 1131 describes series incandescent street lighting systems; 1132 describes multiphase revolving armature alternators; and 1133 describes the single-phase watt-hour meters. Each bulletin is completely illustrated showing the details of the apparatus and the method of application.

OVERCOMING TIME AND SPACE have always been attractive problems for humanity, and anything which assists in solving the problem is of distinct benefit to the race in its effort. "Three little stories of three big events," is the title of an interesting booklet, telling the part that the lubricants made by the International Acheson Graphite Co., of Niagara Falls, N. Y., have had in three recent achievements, the flight over Niagara Falls, the Indianapolis 500-mile race, and the Vanderbilt Cup race. The descriptions and appreciative letters from the users show what Oildag, Gredag and Aquadag have accomplished for high speed and reliability in lubrication.

TESTS OF NICKEL-STEEL RIVETED JOINTS by Arthur N. Talbot and Herbert F. Moore, has just been issued as Bulletin No. 49 of the Engineering Experiment Station of the University of Illinois. This bulletin describes tests of riveted joints of nickel-steel in tension and in alternated tension and compression. The slip of rivets and the strength of joints were determined. From the tests, the general conclusion is drawn that in riveted joints, designed on the basis of ultimate strength, the use of nickel-steel may be of advantage; but that in riveted joints designed on the basis of frictional hold of rivets, while it may be advantageous to use nickel-steel for the plates, rivets of ordinary steel seem to resist slip as well as rivets of nickel-steel.

Copies of Bulletin No. 49 may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

COMPRESSORS, issued by Ingersoll-Rand Co., 11 Broadway, New York City, is the title of Bulletin 3007. It has 24 pages, descriptive of class PB power driven air compressor, duplex type, with the air cylinders close coupled to the frame and a central driving wheel. The catalog shows several views of the machine in section, and gives tables of sizes and capacities. The distinctive features of this PB design are its massive, powerful construction and its simplicity; rugged strength, ample reserve power and unlimited capacity for hard work. The machine is readily accessible, inside and out, and is provided with flood lubrication system. Automatic control of the pressure, and regulation of output to load, are provided by governing devices. Copy of the catalog can be had on request.

IN A 32-PAGE PAMPHLET, entitled A Steam Turbine for Driving Direct-Current Generators, the DeLavel Steam Turbine Co., of Trenton, N. J., presents an extended discussion of the different types of steam turbines and their comparative merits. It takes up the topics of steam and bucket velocities; different methods of speed reduction by means of velocity stages, pressure stages, combinations of the 2 and by means of gears; the peculiarities of turbo-generators; and turbine-driven direct-current generators; and other matters connected with the compromise which must necessarily be effected between the speed of the spouting steam and the best speed of the driven unit. The compromise favored for large units is the combination of multi-staging with reduction gears, the use of the reduction gear permitting the driven machine to be operated at the speed desired, while at the same time allowing the turbine to be designed for the speed most favorable. Copies of this pamphlet will be sent upon request to those interested, who mention Practical Engineer.

A NEW CATALOG of the Taylor stoker has just been issued by the manufacturer, the American Ship Windlass Co., Providence, R. I. The stoker is well illustrated with the parts named in several views. Other illustrations show well-known power plants, such as the Christian Street Station of the Philadelphia Electric Light Co., The Everett Mills of Lawrence, and the Oxford Paper Co. of Rumford Falls, Maine. This catalog is of 40 pages, 6 by 9 in., and can be had by mentioning Practical Engineer and writing to the American Ship Windlass Co.

AN INTERESTING BIT OF EXPERIENCE with gaskets is described in a circular, entitled "Five Years and Still Giving Satisfaction," just received from the Smooth-On Mfg. Co. It tells of an order of 614 gaskets supplied to the De Lamar's Copper Refining Co., at Chrome, N. J. Mr. Addicks, superintendent of that company, states that after 5 years' use the steam lines have remained tight and the gaskets have given no trouble whatever. Copy of this circular can be had by any engineer who will send his name and address to the Smooth-On Co.

BULLETIN NO. 2, issued by the A. D. Granger Co., of New York City, describes the Star safety water-tube boilers for power, steam and hot water heating.

BULLETIN 103, just issued by the Wheeler Condenser & Engineering Co., is a new edition of its bulletin on the Wheeler-Edwards air pump for operation in connection with surface condensers, handling both the air and condensed steam. The function of the air pump and its relation to the condenser proper are first taken up and then the construction and operation of the Wheeler Edwards Air Pump and a comparison of the efficiency of that pump with other types handling air and condensate, discussed in detail. This bulletin contains upwards of fifty illustrations, including photographs. Copies will be sent by the Wheeler Condenser & Engineering Co., of Carteret, N. J., to en-

gineers and others on receipt of request, mentioning Practical Engineer.

ECONOMICAL STEAM POWER PLANTS is the title of a 24-page, 9 by 12 pamphlet reprinted from the technical journals and issued by the Green Fuel Economizer Co., of Matteawan, N. Y. Four of the largest modern steam power plants, viz., the Hudson and Manhattan Power Station in Hoboken, N. J., the 120,000-hp. St. Denis Plant near Paris, the plant of the Laclede Power Co., St. Louis, and the Electric Plant at Vitry sur Seine, are each described by well-known authorities on the design of large steam power plants. It is shown that whereas there is little economy in reducing the temperature of chimney flue gases lower than 500 to 550 deg. F. by means of boiler surface, the temperature of the same gases may be reduced to 200 or 250 deg. F. quite profitably by means of economizer surface. Copies may be had by mentioning Practical Engineer and writing to the Green Economizer Co.

## TRADE NOTES

THE SKANEATELES PAPER CO., Fulton, N. Y., has recently purchased of the Ohio Blower Company, Cleveland, Ohio, 5 60-in. Swartwout Rotary Ball-Bearing Ventilators. Other paper companies who have made recent purchases of Swartwout products are the Hinde & Dauch Paper Co., Sandusky, Ohio, 4 36-in. and 8 18-in. ventilators, Miamisburg Paper Co., Miamisburg, Ohio, 1 24-in. ventilator, and the Analomink Paper Co., North Water Gap, Pa., 1 30-in. ventilator.

PROMINENT AMONG THE exhibitors at the American Exposition of Brewing Machinery, Materials & Products, which was held at the Chicago Coliseum, Oct. 12-22, was the Schaeffer & Budenberg Mfg. Co., of Brooklyn, N. Y. Mr. W. H. Shenton and Mr. T. J. Menten officiated at the booth. As usual they showed a complete line of high grade engineering instruments, a leader among these being the new recording thermometers. Its special features are the mercury filled steel capillary tube and the night and day chart, both new departures in thermometer construction. The new steam engine and ammonia compressor indicator was prominent by its many improvements; also the reform thermometer and an attractive display of engine room clocks.

RECENT SALES of Swartwout Rotary Ball Bearing Ventilators are reported by the Ohio Blower Co., Cleveland, Ohio, as follows: 4 24-in. to Morris Machine Works, Baldwinsville, N. Y.; 2 12-in. to Revere Rubber Co., Providence, R. I.; 3 12-in. to National Whale Bone Co., New York City; 1 48-in. to Rome Brass & Copper Co., Rome, N. Y.; 1 48-in. to Union Mfg. Co., New Britain, Conn.; 1 30-in. to Southern Heating & Metal Co., and 5 12-in. to The Leighton Supply Co., Ft. Dodge, Ia.

THE GOULDS MANUFACTURING CO., of Seneca Falls, N. Y., manufacturers of pumps, reports that its business now is running at only a slightly lower rate than last year, which was the biggest in the history of the company. A representative says: "This year's business in hand pumps and small machinery is the biggest we have ever had, while our business in the large power pumps and heavy machinery is slightly lower than it was last year. As has been the case for several years past, our export business is good and showing a steady increase."

A CENTRIFUGAL PUMP set, driven by a Terry steam turbine, which was recently installed on the U. S. Battleship Arkansas, is believed to be the first steam turbine used for driving circulating pumps on ship board. The results of tests on its performance will prove of decided interest.

THE VILTER MFG. CO., with offices at 972 Clinton St., Milwaukee, Wis., has found it necessary on account of increased demands to establish larger quarters on the coast and announces to the trade its removal from 514-515 I. W. Hellman Bldg., Los Angeles, Cal., to 2612 So. Main St., Los Angeles, where larger quarters have been secured, comprising not only an office but also a storehouse where a complete line of ammonia fittings and sundries, as also small ice and refrigerating machines, as well as ice tanks will be carried in stock. Telephone connection is maintained by "Sunset" South 636 and "Home" 24203. C. M. Gay who has been connected with The Vilter Mfg. Co. for many years, continues in charge.

THE SISTERSVILLE ELECTRIC LIGHT & Power Co., of Sistersville, W. Va., have placed an order with the Mesta Machine Co. of Pittsburgh, Pa. for 1 20 by 24 in. twin tandem, horizontal, double acting, 4 cycle gas engine. The engine will operate with natural gas and is rated at 1000 b. h. p., being arranged for direct connection to a 650-kw., 60-cycle, 2300-volt railway generator.

YORK MANUFACTURING CO. reports the following among its recent sales: Yakima Artificial Ice & Cold Storage Co., North Yakima, Wash., one 35-ton ice making plant; B. Altman & Co., New York, N. Y., 2 60-ton compression sides and fur cooling plant; Rifle Ice & Storage Co., Rifle, Colo., one 20-ton compression side, and 6-ton freezing and distilling system; Central Wharf Cold Storage Co., Portland, Maine, 2 30-ton refrigerating machines, and complete plant for fish freezing and storage house; Standard Oil Company of La., Baton Rouge, La., one 150-ton absorption refrigerating plant; Falfurrias Power Co., Falfurrias, Tex., one 20-ton refrigerating machine; Morgan County Cold Storage Co., Berkley Springs, W. Va., one 30-ton compression side and piping for cold storage plant; W. E. Blumenstein & Co., Sullivan, Wis., one 11-ton refrigerating plant; Alma Light & Ice Company, Alma, Kansas, one 10-ton ice making plant; Lone Star Brewing Co., San Antonio, Texas, one 100-ton freezing and distilling system; Kennedy & Company, Wiggins, Miss., one 85-ton refrigerating machine; Panama Brewing & Refrigerating Co., Panama, one 65-ton high pressure side; Miller Ice, Coal & Bottling Co., Iola, Kansas, one 35-ton compression side, 10-ton freezing and distilling system, and piping for ice cream plant; Thomas A. Edison, Inc., Orange, N. J., one 6-ton refrigerating plant; Anheuser-Busch Brewing Assn'., St. Louis, Mo., one 150-ton refrigerating machine.

ANOTHER ORDER HAS been placed with the Pittsburgh Gage & Supply Co., Pittsburgh, Pa., by the Jones & Laughlin Steel Co., for a large White Star oil filter, which will be used in the Aliquippa Works, at Woodlawn, Pa. Orders for large Duplex and Multiplex White Star filters have also been placed by the William Tod Co., Youngstown, O.; Allis-Chalmers Co., Milwaukee, Wis.; Wisconsin Engine Co., Corliss, Wis.; Geo. S. Batcheller & Co., Bridgeport, Conn.; Excelsior Pocahontas Coal Co., Ware, W. Va.; Philadelphia Co., Sisterville, W. Va.; Standard Plate Glass Co., Butler, Pa.; and Trinidad Electric Transmission, Railway & Gas Co., Trinidad, Colo. The Pittsburgh Gage & Supply Co. states that orders during July and August were not good, but that a very satisfactory increase has been noticed this month, especially in the oil filter and oiling system line.

# PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

**Advertisements in this section are inserted under regular headings at the rates of 40 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.**

**Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.**

**To insure proper classification, copy must reach this office on or before the 20th of month preceding publication.**

## Positions Wanted

POSITION WANTED—By chief engineer. Have had eight years' practical experience with boilers, engines and steam turbines. Am employed as chief of a turbine plant now, but wish to change locality. Strictly sober. Address Lock Box 162, Ione, Wash. 11-1

POSITION WANTED—As engineer or electrician in power plant. At present employed by large manufacturing company as tester of A. C. and D. C. generators and motors. Technical education and strictly sober. Address Box 192 Practical Engineer, Chicago, Ill. 11-1

POSITION WANTED—Stationary engineer, technical education; 15 years' practical experience; am a good erector and pipe fitter. Can manage dynamos and engines. Have indicator and tool kit. Will go anywhere on short notice. Good references. Will work on trial to prove ability. Address Box 190, Practical Engineer, Chicago, Ill. 11-1

POSITION WANTED—Superintendent in electric light plant or where superintendent and chief engineer is combined position. Place where there is "fuel leak," and labor and other costs are considered too high. Right up to the minute on engines, pumps, boilers, A. C. and D. C. apparatus. Have my cost sheets for past four years in large railway plant. Desire a change. Address Box 191, Practical Engineer, Chicago, Ill 11-1

POSITION WANTED—Detroit Agency by steam, electrical engineer. Experienced in selling specialties in above lines. Address C. O. R., 112 24th St., Detroit, Mich. 10-2

POSITION WANTED—In power plant as engineer. Eight years' practical experience and technical training. Now employed as chief in electric plant. References furnished. Address Box 252, Carrollton, Ill. 10-2

POSITION WANTED—By live, energetic, up-to-date gas engineer and electrician. 14 years' experience with several makes of engines. A. and D. Current. Good erector. Neat, reliable, strictly sober and a hustler. Can go anywhere at once. Address Box 189, Practical Engineer, Chicago, Ill. 10-2

## Help Wanted

SALESMAN WANTED—TO SELL BEST known Vegetable Boiler Compound on the market—used all over the United States. Wrinkle Paint Mfg. Co., Columbus, Ohio. 11-1

HELP WANTED—ENGINEER OR SPECIALTY salesman in each town to furnish lists of gasket users and information on new installations and act as our agent for "Duplex Akron" corrugated copper gaskets; "Sure Shot" steel superheat gaskets; Lead Manhole gaskets; Lead ammonia gaskets, and Valve-Tite metallic packing; you have this information; we will pay for it; you don't have to make the sale, our goods and prices will do that. Address Dept. F., Akron Metallic Gasket Co., Akron, O. 11-1

HELP WANTED—ENGINEER WANTED in every city and town to instruct our customers in indicator practice. If you have a fair working knowledge, we will "do the rest." Good pay to reliable, intelligent men. See our adv. on page 19. Write for particulars. Lippincott Co., Newark, N. J.

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-tf

COMPETENT AND EXPERIENCED stoker erectors at once. State age, experience, reference and salary expected. Give full details. Address Box 168, Practical Engineer, Chicago, Ill. tf

BE AN AGENT FOR Practical Engineer in your city. Pleasant part or whole time work calling on your engineer friends. Liberal cash commission on every subscription taken. Write to Subscription Dept. for information. 11-2

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesmen. The Vulcan Soot Cleaner is adapted to all types of boilers. For particulars address G. L. Simonds & Co., No. 803 Steinway Building, Chicago. 7-6

AGENTS WANTED—TO SELL LUBRICATING oils, belts, hose, paint, varnish for power machinery, to factories, mills, auto owners, stores, threshers. Exclusive territory to right party. Oil experience unnecessary. Manufacturers Oil and Grease Co., Cleveland, Ohio.

AGENTS WANTED TO HANDLE ESTABLISHED steam specialty which is known all over the country. Can be handled with non-conflicting specialties. Will give exclusive agency only for amount of territory actually covered by agent or his salesmen in the following states: Virginia, North Carolina, South Carolina, Oklahoma, Wyoming, Georgia, Arizona, New Mexico, Montana, Idaho, Florida, Arkansas, North Dakota, South Dakota. Address Post Office Box 1754, Pittsburgh, Pa. 9-tf

## Wanted

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write the Subscription Dept. They will start you in at once. 11-2

WANTED—5,000 STATIONARY ENGINEERS to send us their name and address. A good proposition open to each one. For full particulars, write Henry W. Lord, 7 S. Greene St., Baltimore, Md. tf.

## For Sale

FOR SALE—One patent Berry boiler; capacity 100 horsepower, good for 125 pounds working pressure; free from scale and recently retubed and is in A. No. 1 condition. Henry H. Sheip Mfg. Co., Columbia Avenue and Sixth street, Philadelphia, Penn. 11-1

FOR SALE—1-125 HORSE POWER, 3 cylinder Webber Producer Gas Engine. Good as new. Used but 3 months. Board of Public Works, South Haven, Mich. 10-2

FOR SALE—INDICATOR, REDUCING WHEEL, planmeter best make in fine order. Examination allowed before payment. Price low, in fact a sacrifice. Address Mrs. N. L. Browning, East Orange, N. J.

## Patents and Patent Attorneys

PATENTABLE IDEAS WANTED—Send for 3 free books R. B. Owen, 28 Owen Bldg., Washington, D. C. 7-tf

PATENTS FOR SALE on three different types of steam traps, including the patterns and drawings for same. Address Box 186, Practical Engineer, Chicago, Ill. 9-tf

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. 10-tf

PATENTS—C. L. Parker, late Examiner U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the inventors. Handbook for investors sent upon request. 186 McGill building, Washington, D. C. 4-tf

## Miscellaneous

MAKE MONEY on the side. Here's your chance to pick out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. 11-3

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write to-day. T. L. Reeder, 1413 W. Jackson Blvd., Chicago, Ill. tf